

No 27

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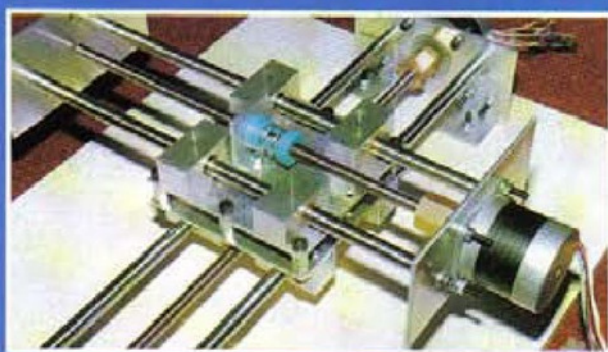
MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

MIX AND MATCH

Using Emco's mill/drill head on the ML7



TOTAL PRECISION?

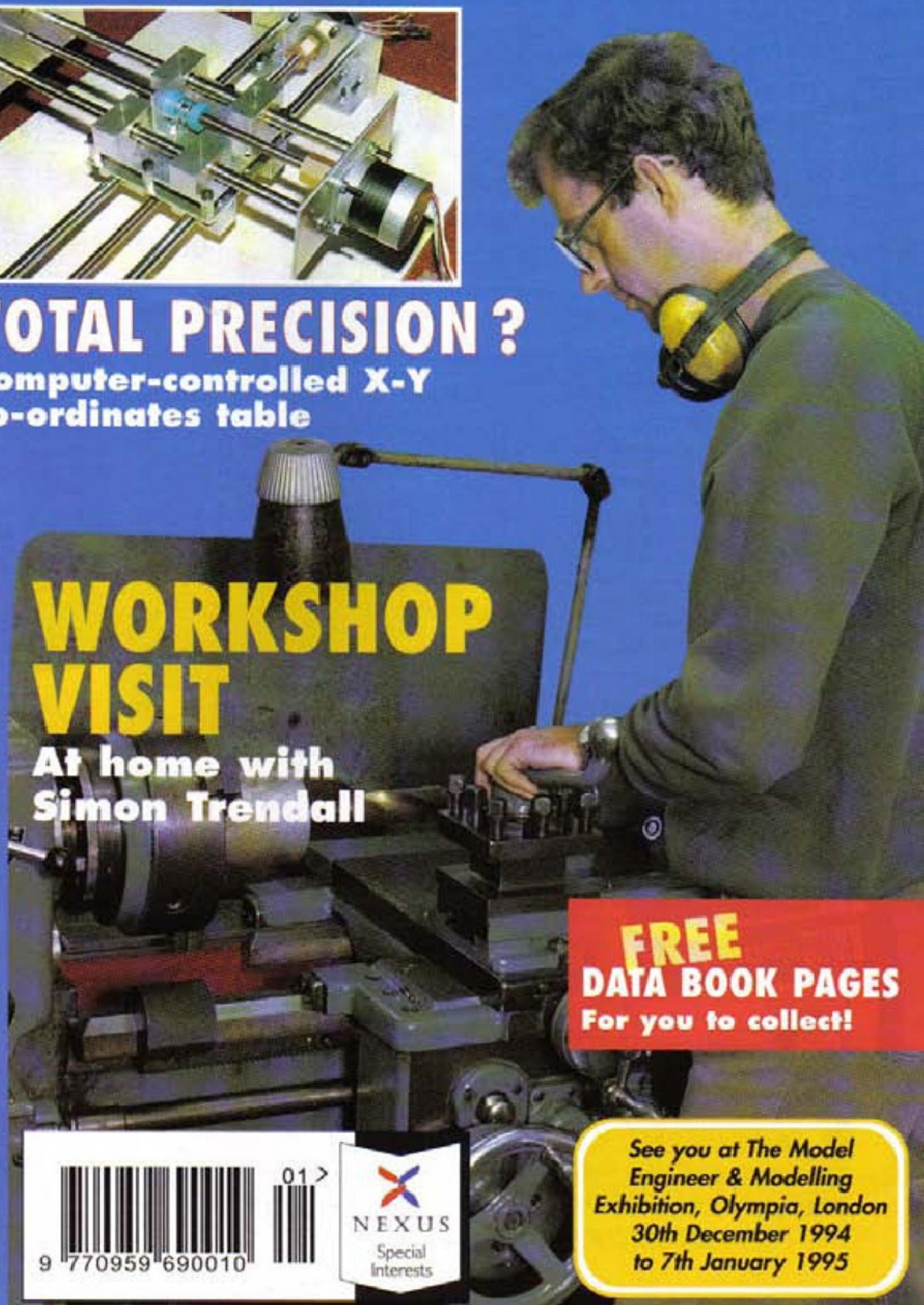
Computer-controlled X-Y co-ordinates table

WORKSHOP VISIT

At home with Simon Trendall

BORING HEADS

Two very different designs



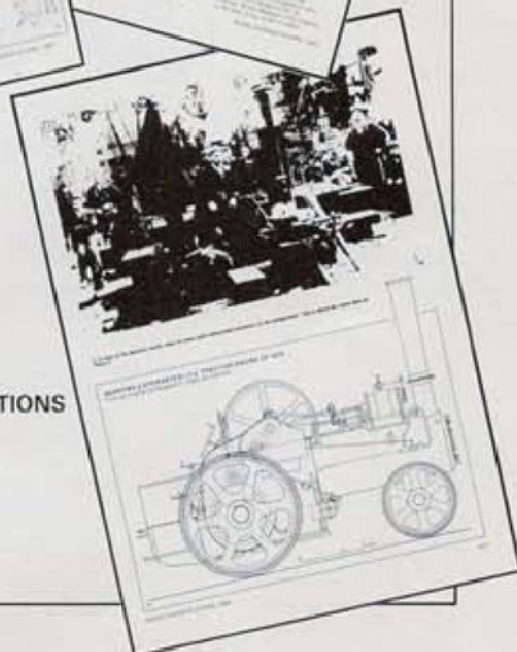
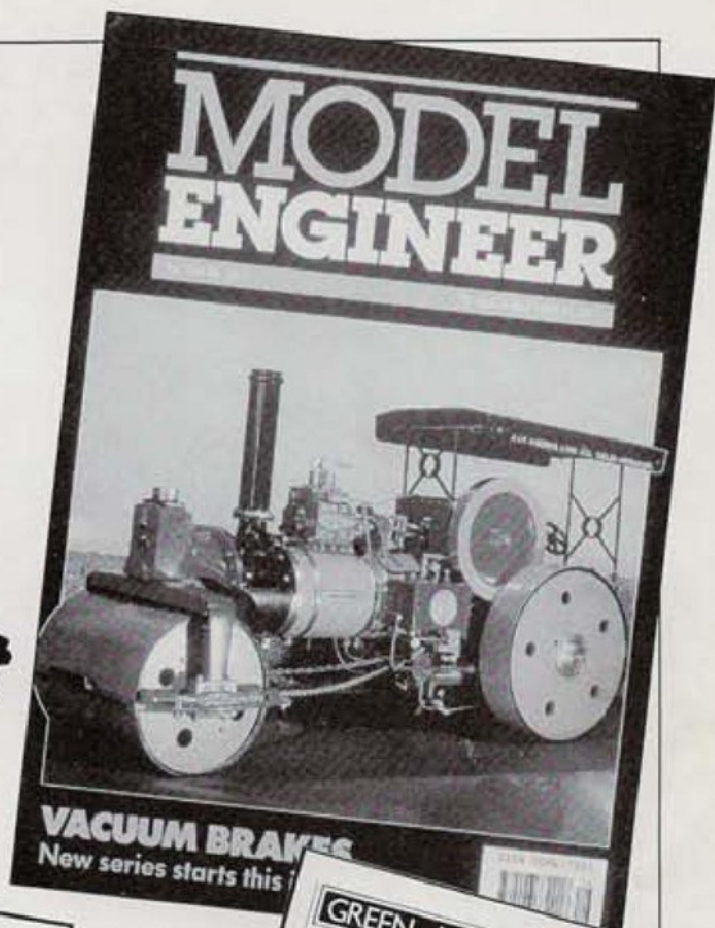
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Special Interests

See you at The Model Engineer & Modelling Exhibition, Olympia, London 30th December 1994 to 7th January 1995

**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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CONTENTS

Issue No.

27

Editor: Harold Hall

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11 ON THE EDITOR'S BENCH

Harold Hall's commentary

12 A WHEEL DRESSING JIG

Freshly faced wheels make cleaner cuts

14 WINDING SMALL SPRINGS

Simple methods produce repeatable springs

17 THE GRIPTRU CHUCK

A useful workholder explained

18 AN X-Y TABLE

Computer controlled, can be used as a plotter or for light milling

27 A BORING HEAD

Interesting to make and very useful

30 A DRILLING METHOD FROM THE PAST

Not quite the Boxer revolution – a useful workshop method

32 LIGHT DUTY MILLING/ DRILLING SPINDLE

An ideal supplementary tool for the lathe

34 WE VISIT – SIMON TRENDALL

Military vehicle restorer extraordinaire

36 LOW COST VERTICAL SLIDE

A converted compound vice forms the basis of this effective tool

39 LINK UP

Reader to reader, help, sales, wants, your page

40 TWO WAYS TO PULL A FAST ONE

Crafty disassembly dodges

41 TRUING DRILL CHUCKS

Practical advice

43 BORING HEAD FOR THE HOBBYMAT MD65

Dedicated tooling adds to the use of a versatile machine

48 ADDING A FINE FEED TO A DIGITAL CALIPER

Gain even more sensitivity with this add-on extra

51 A TANGENTIAL SKIVING TOOL

And you thought that skiving was dodging the column!

55 EASY SET DIE HOLDER

For constant sized threads

56 THREE WAY TOOL POST

A useful concept – saves slit fingers and problems with trailing tools

59 A LOW RANGE TORQUE WRENCH

Make sure that smaller bolts are correctly tensioned

61 TRADE COUNTER

Product news

61 A QUICK CHANGE TOOL HOLDER

Corrections to a published design

62 USES FOR THE EMCO 3 MILL/DRILL HEAD

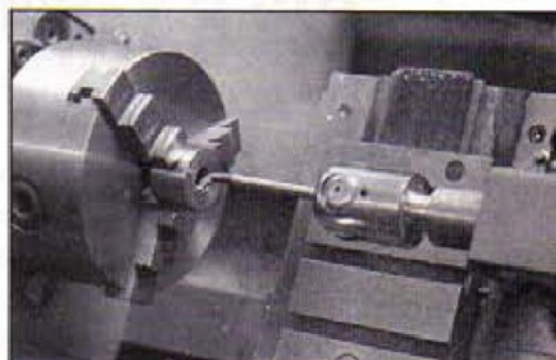
Ingenuity makes this a useful tool, at minimal expense

68 SCRIBE A LINE

Readers address readers

MODELLER ON THE COVER

Using a rather larger drill than usual in model engineering circles is Simon Trendall, engaged on machining a part for one of the military vehicles currently being restored. Story, page 34.



Seen here in use from the tailstock, this versatile boring head can also be used from the mandrel to operate on a job held on the cross slide. Making it is well within the scope of most home workshop enthusiasts. A description starts on page 27.



HOTLINE
SUBSCRIPTION
& BACK ISSUES 01737 768611

This very neat conversion is just the thing for those who have a lathe without easily obtainable milling facilities. Read about the idea, and how you can make a similar tool, starting on page 36.

ADVERTISERS' INDEX

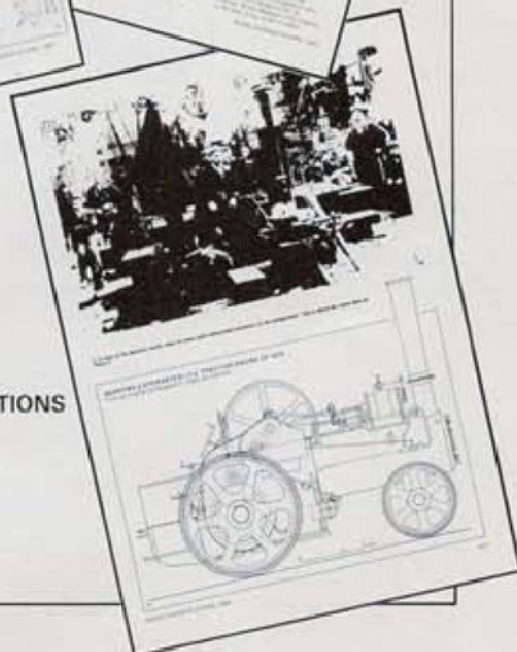
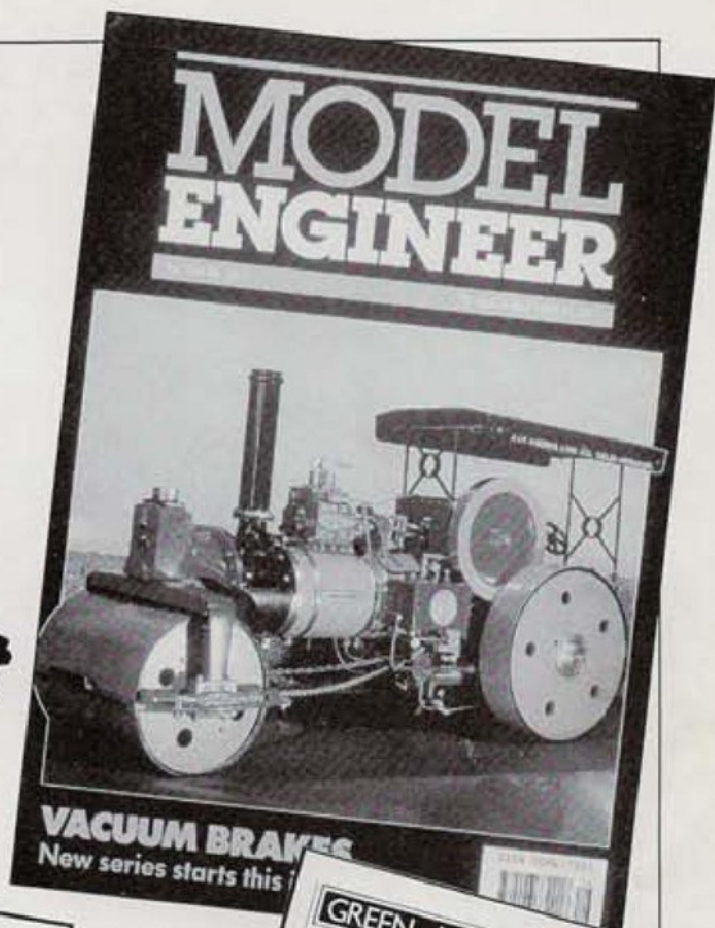
ADVERTISERS' INDEX									
B					Q				
Blackgates Eng.	70				Quality Eng. Sup.	73			
Brighton Centre	73				R				
C		E		I					
Camden Min. Steam	5	Elliott Engineering	10	Intercity Mach.	73	Millhill Tools	74	A. J. Reeves	
Chester (U.K.)	74	Emco Maier	2	K		Model Engineering		(B'ham) Ltd.	8
Chronos	8	G		C & H King	75	Services	75	S	
Compass House		G & M Tools	6	Kirjeng M.E.	75	Myford	9	Stanton & Thompson	
Tools	70	GLR Dist.	73	L		N			75
Cowells Mach.	69	Graham Central	70	I.A. Services	75	Newton Tesla	35	T	
College Eng.	75	Graham Eng.	74	M		Nexus Special		TEE Publishing	7
Crew J.A.	75	H		Macc M.E.	77	Interests Ltd.		W	
C.Z. Scientific	10	Home and Workshop	79	Maidstone Eng.	74	4, 42, 71, 72		Warren Machine	
				M.E.S. (Bexhill)	75	P		Tools	78
						Proops Bros.	9		

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ON THE EDITOR'S BENCH

Harold Hall

In this issue we have an interesting range of articles. Again there are more smaller articles than have appeared in many earlier issues. I hope you find an occasional magazine like this interesting, no doubt you will let us know if you feel otherwise.

In the last issue I mentioned that Geoff Gray, the author of one of our more sizeable constructional items in the past, had produced some smaller items. There were two of his articles in that issue, and this time we have another of his smaller articles. It is a simple milling/drilling spindle.

The article by Derek Walters is another well worth considering. In this, he purchases a mill/drill head intended for use on one of the small home workshop lathes, and adapts it for use on his own machine. By purchasing the head alone, without motor and other peripheral parts, and using a surplus motor and making other parts, he manages to keep the cost within bounds. He also mounts it onto a small base with column to make a high speed sensitive drilling machine.

The Model Engineer Exhibition

As most readers will know the Exhibition is again staged at Olympia from 30 December - 7 January. I hope to get along fairly often, and hope to meet many readers. Apart from the interest in the many models and workshop tools on display, there is always the chance of a bargain from one of the many trade stands. Full details are shown on the advert on page 4 of this issue. I hope that many of you will make the effort to attend and enjoy this excellent show.

Disappointing response

I think I can say that, during my time as editor of *Model Engineers' Workshop*, I have been very pleasantly surprised at the response I have had with requests made by me of one sort or another. It would now seem that, at this late stage, a failure has occurred. In *On the Editor's Bench* in issue 25, I indicated that I would prepare a questionnaire relating to older workshop machines. This could be used to gather information on the machines no longer in production. The response to this suggestion has been extremely poor, and I wonder if readers have considered that many others will reply and their contribution would therefore be of little use.

If you have a machine in your workshop that is no longer in production, do please return to my comments in issue 25 and consider offering. The questionnaire is simple, you need only answer those questions that you find easy, and if you do not wish to include your address then this can be left out. I know from the many requests for help that there are many of you with such machines, please do not let me down at this late stage.

Reader Survey

It had not been my intention to comment on the latest reader survey, as I must confess that I had reservations on there being yet another one. The response to this has though been quite different to that above, some 200 hundred replies within ten days is very encouraging. I do not intend to publish a review, perhaps the new editor will include one in an early issue. I would like to make a couple of points briefly here. A number of readers were unhappy, as they have been in the past, at having to remove a sheet from the magazine. If you look carefully you will find the questionnaire is not page numbered and there is no sheet on the other side of the fold. So if you have been deterred because of this, it is still not too late to send in your answers. One thing that an editor soon learns from the answers given, is that it is impossible to please all readers all the time. Fortunately, even in the worst case, those against some aspect of the magazine are always in the minority. One such case is the *Data Book*. Here, a minority, though not insignificant number, appear to be unhappy with this series. I wonder if the question having the word interesting in it was taken too literally, perhaps a better word would have been "useful."

I cannot think of anything more boring than the trigonometrical tables in this issue, but I would find them indispensable had I not got a scientific calculator. I think judgement on this would be best suspended until the wide range of information planned is more evident.

A confessional

There are a number of comments which I would like to make, more or less associated with my leaving. This I had decided to leave until my final issue. It maybe that I will find too much to comment on in that issue, so have brought this point forward. One comment, not infrequently made, by readers of the magazine, has been the number of articles featuring a Myford Super Seven lathe. Most readers will by now have realised that all articles without an author's name have been provided by myself. This means that my Super Seven featured frequently, this added to the fact that many articles by other authors also displayed this machine.

Some authors did not supply adequate photography, so I made and photographed the item myself, further adding to the number. In an endeavour to overcome this I decided to build a second workshop using smaller machines and, when using this, write using a pseudonym. These are the articles under the pseudonym of John Steele.

I decided to come clean on this point, as I anticipate continuing to write articles from time to time and find having to stick rigidly to one workshop, or the other, somewhat inconvenient, particularly when it comes to accessories. In fact I was not too successful in

the first article, and if there are any Sherlock Holmes amongst you, I am sure you noticed one give-away, and at least five other points which collectively might give cause for suspicion.

Try working it out over Christmas and the New Year. Incidentally, the worker on the front cover of issue 24 and seen in John Steele's workshop, is not me sporting a false beard and a wig. He is a close friend who spent some considerable time helping me to build the workshop.

Index

Quite a number of the reader surveys which I have seen thus far indicate some dissatisfaction with the continued absence of a printed Index in the magazine. This as I have indicated previously is due solely to my not being able to find the time to complete this to the standard which I feel the magazine deserves. I will on completion of my term as editor bring my index up to the point where it could be published. This will however be the prerogative of the new editor as to whether mine or some other index is used. I do intend to make cumulative indexes available on paper as well as my computer program. If you are interested in the paper copies, or the software for the computer program, please see *On The Editor's Bench* in issue 26 for how to obtain more details.

Payment for articles, etc.

A reader has pointed out a statement in Issue 1, which implied that payment would be made for ideas published. This statement obviously requires a little qualification. Articles are the only items which receive a payment, letters and *Quick Tips* do not. If you supply an idea which is rather more than a quick tip but in letter form, perhaps with a simple drawing, or maybe a photograph, it will, if used, be published in *Scribe a Line*.

Should you wish to receive payment please ensure it is sufficient to make at least a half page article and make it clear you want it to be used in this way. Authors should be aware that in view of the large number of such items received, it may be at least two years before it is published.

Encouraging signs

I do hope our overseas readers will not mind my being a little nationalistic and offering a word of encouragement to the U.K. readers of this magazine, who in any case are the majority. This week I received a pamphlet regarding Mitutoyo's new 150mm digital calliper, and was pleased to see that it was Made in England. It is encouraging to know that even if the makers name is not of U.K. origin, at least the place of manufacture is in this country. While I have known that Mitutoyo have been manufacturing in the U.K. since 1991 I feel many that readers may well not be aware of this fact.

Telephone number update

It has been pointed out to me that telephone numbers for the Burnley area have now been made 6 digit. The number therefore for A & D Barrowclough Ltd, suppliers of the casting for the Universal Milling/Dividing Attachment in issue 26, is now 0282 427048.



A WHEEL DRESSING JIG

I suspect that dressing the grinding wheel is an operation which is not carried out as frequently as it should be. This wheel dressing jig, provided by S J Curtis, if made, should encourage one not to fall into this trap.

A prerequisite for accurate offhand grinding of lathe tools, is a true face on the grinding wheel. Achieving this with a hand held diamond I found to be nearly impossible because of the difficulty in keeping the diamond steady whilst passing it across the wheel. Fitting a collar to the shank of the diamond holder and bolting a straight edge to the tool rest did not solve the problem. The solution effected by this design is made to fit my Black & Decker P7505 "Professional" Grinder, but, with suitable modifications, could be adapted to other makes.

Construction

Bracket (6)

Make two to the dimensions shown. Each $\frac{1}{2}$ in. x $\frac{1}{2}$ in. strip should be slotted and drilled before bending. Remove the screws securing the spark guards and fix guards and brackets in place with longer screws, $\frac{1}{2}$ in. x $\frac{1}{2}$ in. BSW. The slots permit adjustment for aligning the rail with the spindle axis. Rail (5)

Make this next. Measure the distance between the inside edges of the brackets (hence the reason for making and fitting them first). Prepare a piece of $\frac{1}{2}$ in. dia. BMS, $\frac{1}{4}$ in. longer than this dimension. Turn down each end to $\frac{1}{4}$ in. dia. for $\frac{3}{8}$ in. and thread $\frac{1}{2}$ in. BSF. Two $\frac{1}{2}$ in. BSF nuts and flat washers will be required to secure this.

Holder (1)

Cut a piece of $\frac{1}{4}$ in. sq BMS just over 5in. long. Place in the four jaw chuck and face both ends. Drill and ream $\frac{1}{2}$ in. hole for the rail, making this $\frac{1}{2}$ in. from one end. On an adjoining face mark off and drill the $\frac{1}{2}$ in. hole for the dresser shank and the 5.30mm hole for the $\frac{1}{4}$ in. BSF adjusting screw, which can now be tapped. I positioned the $\frac{1}{2}$ in. hole off centre to allow more threads for the set screw. Drill and tap the $\frac{1}{2}$ in. BSF hole for the set screw. Leave the 6BA holes until you have made the dust seal retainers.

Dust Seal Retainer (2) Face a short piece of $\frac{1}{4}$ in. dia. BMS and drill $\frac{1}{2}$ in. dia. to

about $\frac{1}{8}$ in. deep, enough to accommodate three $\frac{1}{8}$ in. thick washers, plus the width of your parting tool. Scribe across face with the tool in the tool post. Mark the positions of the two 2.30mm dia. holes by positioning the turning tool with the cross slide and scribing intersecting lines by rotating the chuck by hand. Remove the workpiece, place it in the drill vice and drill the two holes, again to $\frac{1}{8}$ in. deep. Replace in the chuck, ensure true running and part off one $\frac{1}{8}$ in. washer. Now take the Holder (1), place it in the drill vice with a piece of $\frac{1}{2}$ in. bar in the $\frac{1}{2}$ in. hole. Place the washer over bar and use it to position holes for the 6BA screws. Drill two x 2.30mm holes to $\frac{1}{8}$ in. deep and tap 6BA. Repeat on the opposite side.

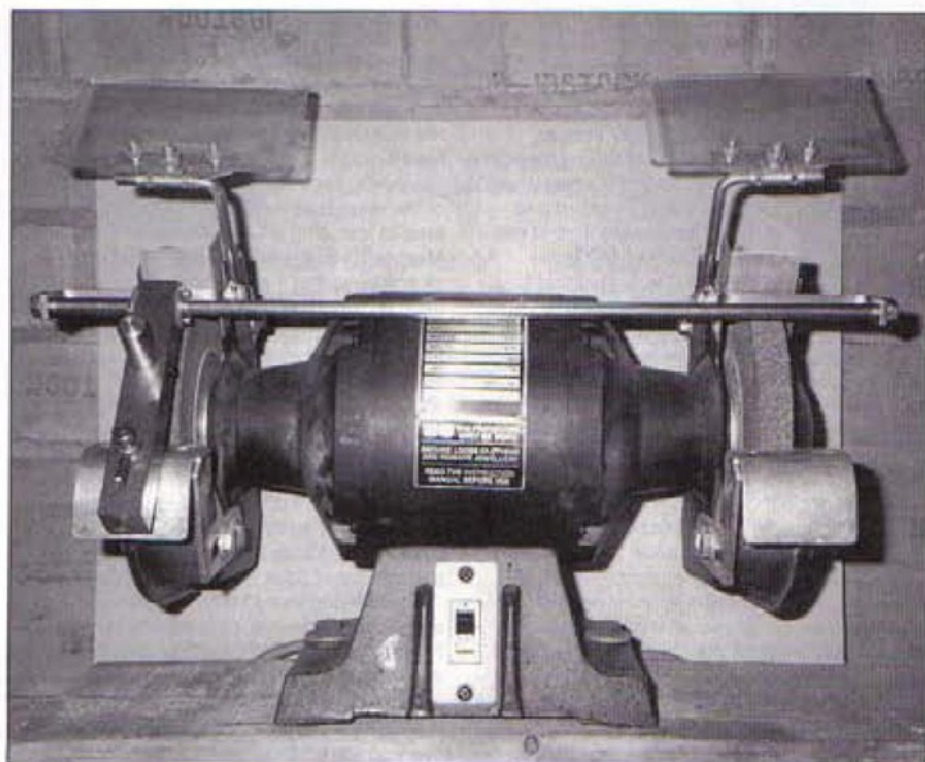
Returning to the lathe, enlarge the $\frac{1}{2}$ in. hole in the workpiece to 8.30mm. Remove, mount in drill vice, and enlarge the 2.30mm holes to 3.00mm. Replace in the chuck, and part off two $\frac{1}{8}$ in. washers.

Locking Collar (3) Arm (4) From $\frac{1}{2}$ in. dia. BMS make collar as shown on the drawing. Drill a 3.00mm x 3.00mm hole on the chamfered edge at 25 degrees angle. Make Arm as shown in the drawing and Loctite or solder into Locking collar. Alternatively, drilling for, and fitting, arm could be left till later, when the position of the hole could be chosen to allow arm to rest in the most convenient position when tightened.

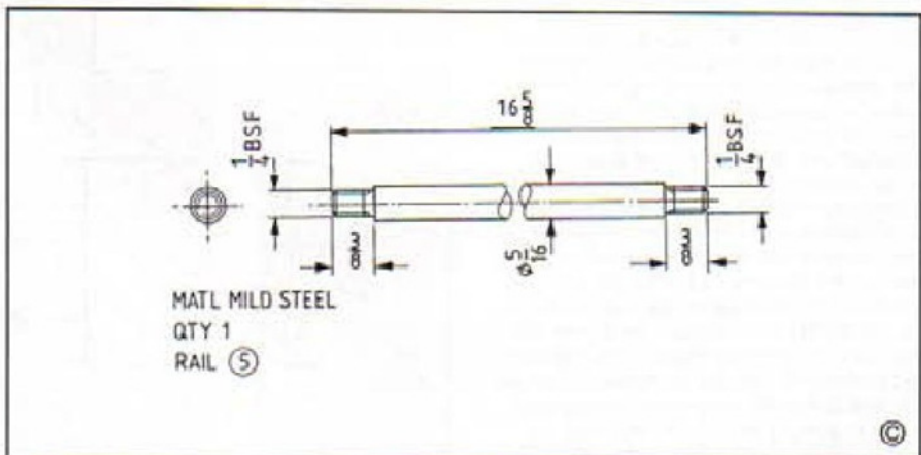
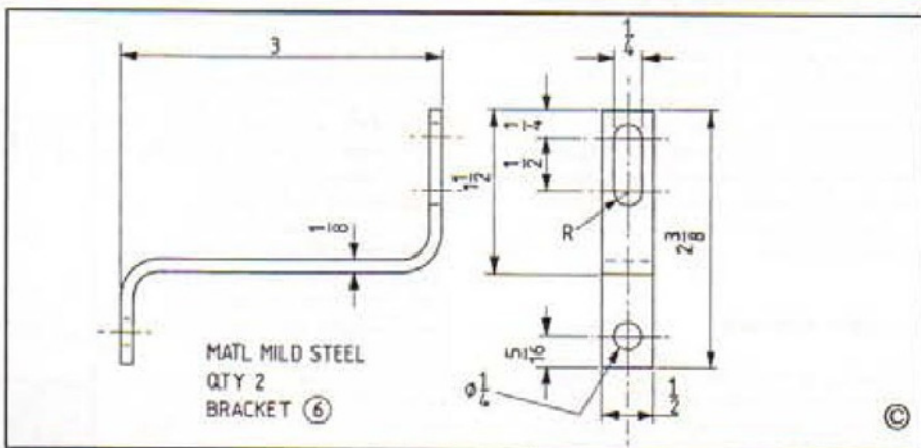
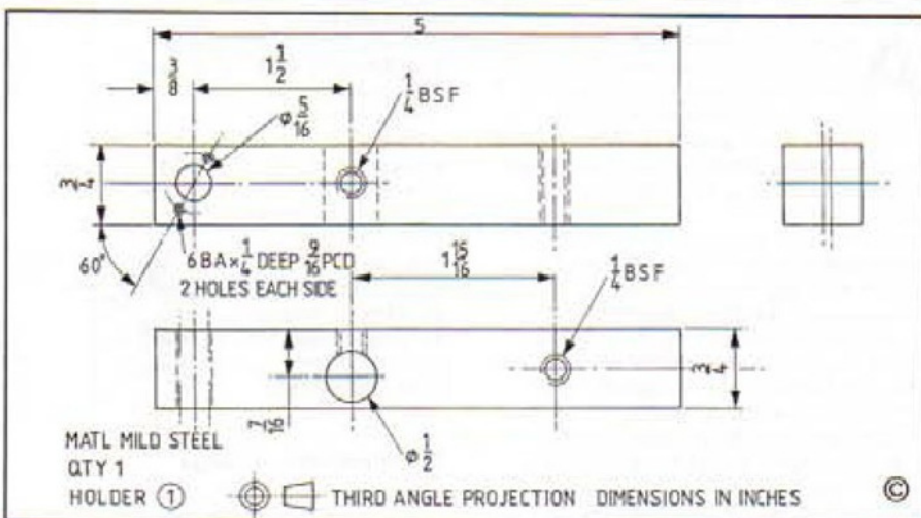
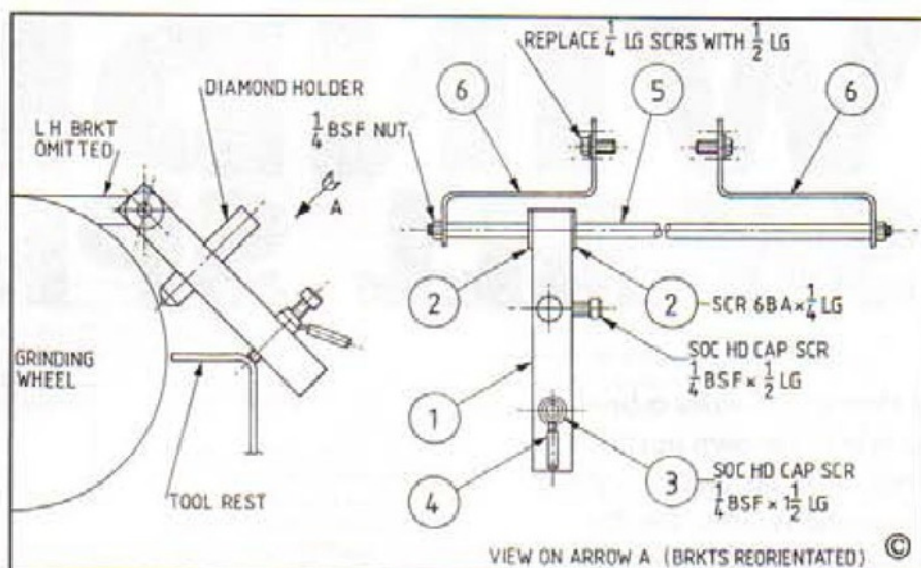
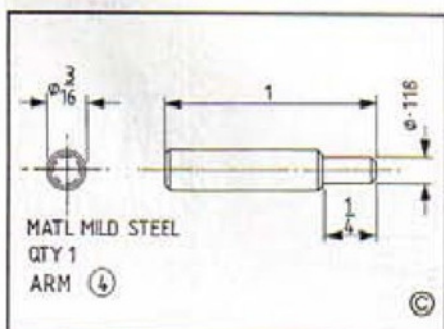
Assembly

Prepare two felt seals of $\frac{1}{4}$ in. dia. At the centre punch out a $\frac{1}{4}$ in. hole to ensure a snug fit on the Rail (5). Using the retainers as templates, mark out the positions of the holes for the 6BA screws. Punch these out. Using a piece of $\frac{1}{2}$ in. bar in the $\frac{1}{2}$ in. hole in the Holder, locate the dust seals and retainers and secure with 6BA screws. Remove the piece of $\frac{1}{2}$ in. bar. Face off the end of a $1\frac{1}{2}$ in. x $\frac{1}{4}$ in. BSF Cap Screw and turn off a couple of threads. Thread on the Locking Collar and insert the screw into the $\frac{1}{2}$ in. BSF hole in the Holder until about $\frac{1}{8}$ in. protrudes.

Temporarily fit the diamond dresser, as depicted on the assembly drawing. Now place the Holder onto the Rail. Insert the Rail into one of the Brackets on the grinder and fit a $\frac{1}{2}$ in. BSF nut. Loosen the other Bracket sufficiently to allow the other end of the Rail to engage in the bracket. Finally, fit and tighten all screws and nuts, ensuring that the Rail is parallel to the grinder spindle in both planes. Slacken the set screw and position the diamond just clear of the wheel. Spin the grinding wheel by hand whilst unscrewing the cap screw (very slowly!) until the diamond just contacts the wheel. Gently tighten the Locking Collar. Rotate wheel by hand to confirm only minimal contact with the diamond.



This jig produces a perfect finish to the wheel and thereby considerably improves the standard of offhand ground tools. It takes only a few minutes to fit as, after use I remove the Holder and Rail only, leaving the Brackets in situ. It could be left fully rigged, with the Holder folded back and resting on the grinder casing.



WINDING SMALL SPRINGS

R Harries provides a brief article in his own particular style, with his unique style of illustrations. This time the subject is winding springs.

A specialised form of bending is the coiling of wire into springs which frequently figure in mechanisms where an automatic restoring force to some movement is required. While the flat leaf-type spring has its uses in this respect, the helical wound variety has more applications.

When a spring is close-wound it is intended for use in tension - if open-wound it is intended for use in compression, **fig. 1**. Messrs. Springmasters of Redditch, Tel. 0527 21000, make a great variety of springs. They can be purchased in mixed collections or specified types.

However the exact spring for the job may not be to hand and be required in a hurry. If this is the case it is not too difficult to wind your own. It is unlikely that any quantity will be needed, so complicated devices for winding them are not required. The spring wire used, whether it is steel or phosphor bronze, is usually in a state of hardness whereby it can be coiled into shape without any preliminary or subsequent heat treatment. Naturally the springiness of the material demands that you wind the spring tighter than finally required to allow for the opening up that occurs on release.

Tension springs

Dealing with tension springs first, the arrangement for winding them is shown in **fig. 2**. A suitable diameter mandrel **A** is selected and one end is bent into a cranked handle or else a detachable handle is added. The other end has a diametral saw cut to receive the hooked end of the wire. The mandrel runs in a bearing hole drilled in the hardwood block **B** which is clamped vertically in the vice. There should be sufficient mandrel exposed at **C** to allow for the length of spring required. A spring-loaded metal clamp plate **D** secured by two wood screws keeps the feed wire under tension and a shallow V-groove on its inner face guides the wire. To wind the spring, withdraw the mandrel to the right, pass the wire under **D**, draw through and form the end hook. Engage the hook in the saw cut and proceed to turn the mandrel which will traverse to the left as the wire is wrapped round it. Having wound the required length, snip the wire at the outer edge of **D**

and continue to wind until clear of **D**.

The spring is now free to withdraw endways. An allowance should have been made on the length for the formation of the end eyes. To form the eyes, first nip off the beginning and end straight portions, then lay the spring on a flat surface and prise over one or two end turns, **fig. 3**, using a wood chisel. Two turns give a stronger anchorage. These eyes have now to be twisted so that their planes lie diametrically in relation to the main spring. This can be done by squeezing in the loop with a pair of pliers as in **fig. 4**, making sure that the wire leading into the eye assumes a smooth curve and not a sharp kink.

Compression springs

A very similar contrivance is needed to wind open springs. This is shown in **fig. 5**. The mandrel is as before, but the hardwood block **B** is sloped on the wire guiding face to the helix of the required spring. The clamp plate **D** is similar to **fig. 2**. The actual winding procedure is as for tension springs, the spacing of the turns being determined by the angle of obliquity of the feed wire. Variation of this angle will affect the openness of the spring. It is not customary to form anchorage loops on the ends of compression springs but rather to wind the first and last turn close and then grind the faces off square, **fig. 6**. To do this on our winder, first

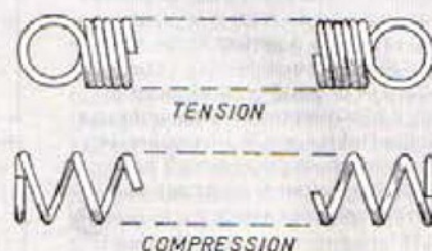


Fig 1

Fig 2

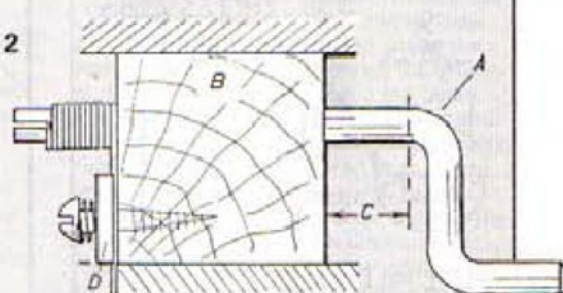


Fig 3

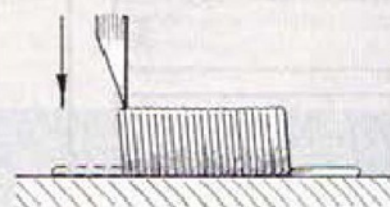


Fig 4

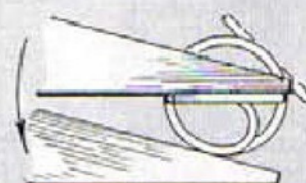


Fig 5

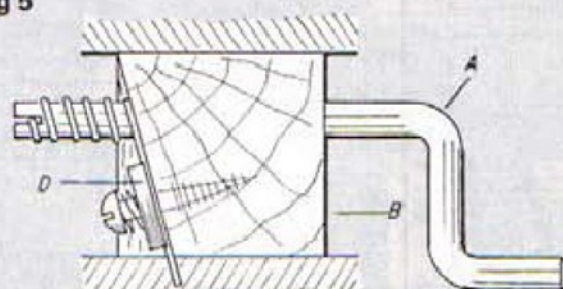
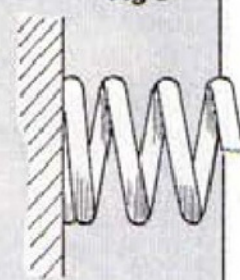


Fig 6



start with the clamp plate slackened off so that the wire can be fed on square to the mandrel and one close turn wound onto the mandrel. Alternative tension can be provided by holding the wire with a pair of pliers, the tighten down the plate to continue normal winding, until the end is reached when the process is repeated. If a number of springs is needed it would pay to face the side of the block in figs.2 and 5 with Formica or metal to limit wear caused by the wire running through.

An improvement to the winder of fig.5 could be made to avoid slackening off the tension plate for the above operation; which would also allow springs of any pitch as well as close wound ones to be made at will, as seen in **fig.7**. This ability to vary the spring winding from close-wound to any pitch open-wound, instantly enables one to wind in tandem, a series of compression springs with close coiled ends so that they can be chopped up into individual springs later, **fig.8**.

The rig of fig.7 consists of a hardwood block **A**, held in the vice. The left hand upper part is cut back at an angle to allow the arm of the T-hinge **B** to swing to the right out of the square position. The cranked handle mandrel **C**, on which the wire is coiled rotates and slides in a bearing hole in **A** and passes through an appropriately placed elongated hole in **B**. A slot and collar on the outer end of **C** anchors the wire which passes under a groove in the Spring loaded plate **D**. Nearer to the outer end of **B** is secured a long screw **E** passing between the gap formed by two nails **F**. Nuts on the screw act as adjustable stop faces. The right hand

nut is set to bring the arm of the hinge square to the mandrel axis when swung fully to the left and the left hand nut position controls the pitch of the coils when the arm is swung to the right. If necessary the arm can be locked in any position by screwing the nuts together to grip the nails. The procedure in winding a fully close wound spring and the starting coils of an open wound spring is to thread the wire under the pressure plate (suitably adjusted for tension) and push its end into the slot in the mandrel **C**. Having previously set the stop nuts, the mandrel is then rotated by hand, keeping the hinge arm steady, as shown in **fig.9**.

The mandrel will traverse to the left as winding proceeds. If an open wound spring is being tackled, a start is made as in **fig.9** to wind a few turns close; then the hinge arm is swung over to the right, **fig.10** to continue winding an open coil. As the desired length of spring is reached, swing the arm back to position **fig.9** to finally wind the close end turns. Cut the wire outboard of the pressure plate and continue winding the mandrel to free the spring. Slide off the mandrel by removing the collar. The winding of several springs in tandem as in **fig.8** consists of repeating the above procedure for as many times as the mandrel length will allow.

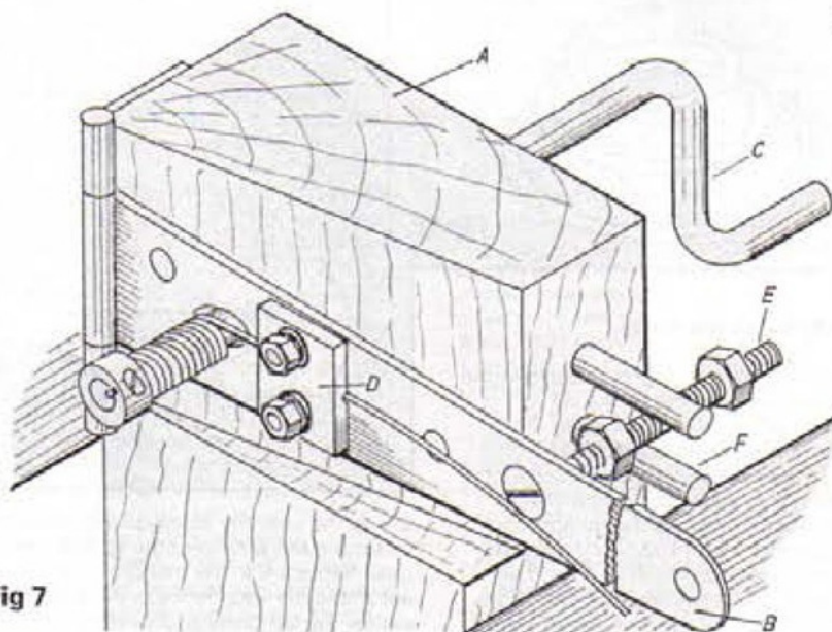


Fig 7

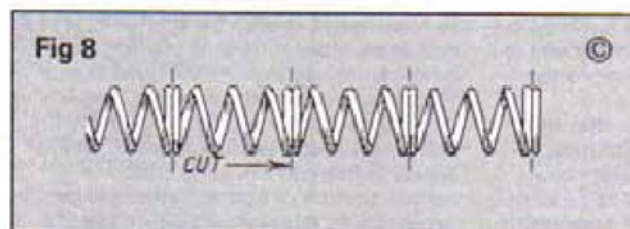


Fig 8

Tapping compound alternative

If you are out of tapping compound, ordinary household soap will work quite well. Indeed, it is better than lubricating oil.

Alan Jeeves

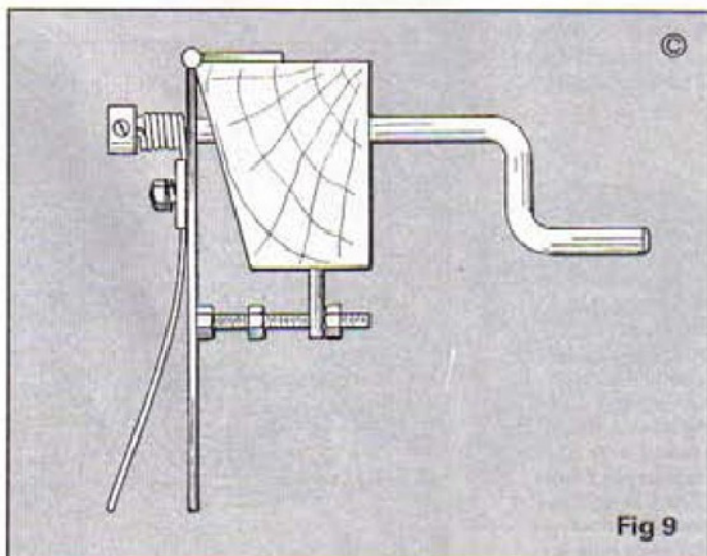


Fig 9

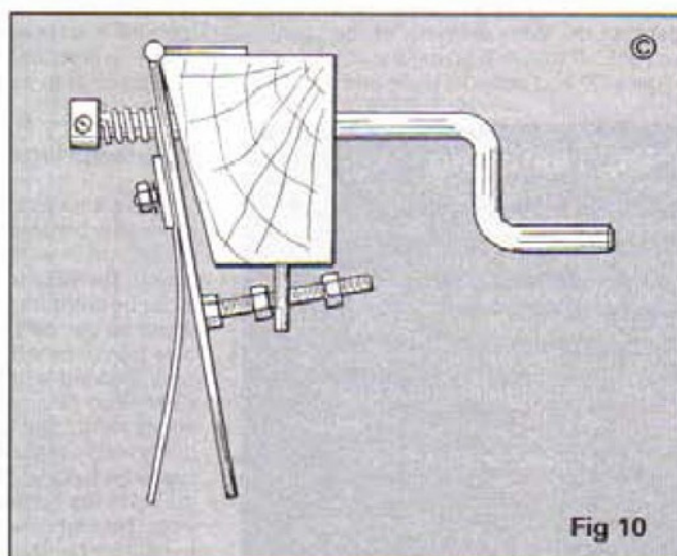


Fig 10

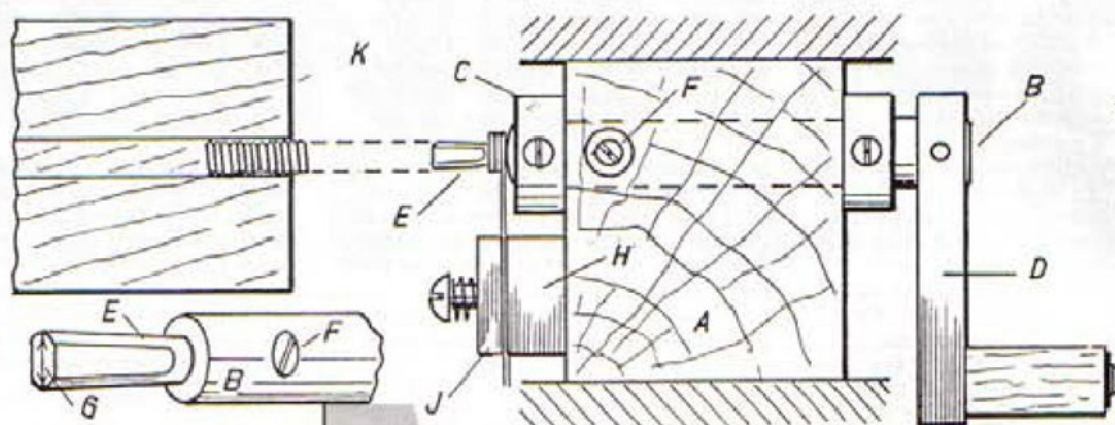


Fig 11

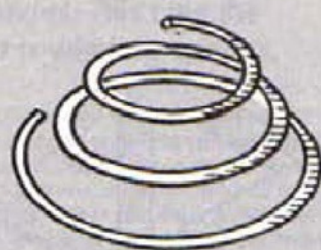


Fig 12

Springs for drive belts

It may happen that a long closely wound spring of small diameter is needed for perhaps a belt drive or some other purpose. It is not possible to wind such a spring by the above methods on account of the torsion that would occur in driving a long thin mandrel so a different approach must be made. **Fig.11** shows the layout necessary to produce such springs. The hardwood block **A** clamped upright in the vice is bored to take the mandrel **B**, located by collar **C** and rotated by the cranked handle **D**. The front end of **B** is domed, polished and drilled axially to accept a silver steel rod extension **E** which is held in place by the side screw **F**. The outer end of **E** has been swaged flat on two opposite faces so as to gradually increase the diameter **G**. It is advisable to harden and polish **E** to resist wear and reduce friction. A metal plate **K** and a spring loaded cover plate **J** enable predetermined loading to be applied to the wire. The winding operation takes place as follows. First wind a short length of spring on an independent mandrel, the same diameter as the plain part of **E**. Remove **E** (using the access hole to get at **F**) and press its plain end through

the spring until the enlarged end enters, so distorting the section of the spring into an oval. Replace **E** in the mandrel and assemble the wire between the tensioning plates. By temporarily distorting the section of the spring, a drive is secured to draw the wire through when the mandrel rotates. Continued rotation causes the wire to force itself between the domed face of **B** and its previous turn, thus pushing the whole spring axially. As the outer end of the spring rides off the mandrel it reverts to its original circular section. Obviously the conditions that make it possible to wind a spring in this way are fairly critical; a certain amount of trial and error will be necessary to achieve the right shape of **E**, and the tension on the wire. As the spring which comes off **E** is rotating like the mandrel it is necessary to convey it along a track in a horizontal board **K**, mounted near the vice so as to prevent it getting tangled up.

drilled down the head end of **A** to accept the rod **C** on which the spring is wound. The outer end of **C** terminates in an enlarged collar **D**. A flat filed along the top of **C** provides a surface for the clamp screw **E** to locate firmly. The procedure in winding is to bend the tip of the wire at right angles, tuck it in the space under screw **E** and press in **D** so that the gap between it and the bolt end is equal to the diameter of the wire. Tighten screw **E** to lock the wire and **C**.

Now wind as many turns as required, cut off the wire and release the spring from the mandrel. Finally place the spring on the bench, hold down the outer turn and pull the centre up with a pair of pliers, **fig.14**. The projecting tag end is then nipped off with the cutters.

Volute springs

There are situations where there is little room to accommodate a compression spring and in such cases a volute type spring, **fig.12**, can solve the problem since it can be compressed if needs be into a depth no greater than the diameter of the wire from which it is made. A way to wind such a spring is to coil it up like a clock spring and then pull it out axially into a volute form. The winding device **fig.13** for this spring consists of a mandrel **A** which is a large hexagon bolt, turning in a hole drilled in the hardwood block **B** held in the vice. The right end carries a cranked handle for hand drive. An axial hole is

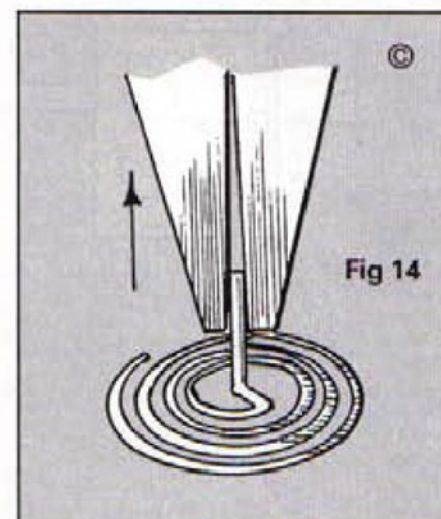


Fig 14

Tap restoring

Taps which are showing signs of bluntness can easily be sharpened by stoning the-cutting edges in the flutes. Usually only the first few threads have dulled and the restoration of a good cutting edge is simple if plenty oil is applied while stoning.

Alan Jeeves

THE GRIPTRU CHUCK

Allan Jeeves discloses the secrets of the Griptru chuck.

Self centring 3-jaw chucks are an innovation of the 19th century and were a successful method of speeding up the chucking of work in the lathe. The 4-jaw independent chuck, which was a natural progression from the era of faceplate dogs which could be separately adjusted to centre the work (or throw it off centre as the case may be), was a means by which a job could be exceptionally accurately centred but precious time was spent in so doing. If it is not essential for the workpiece to be running dead true, for example if all the turning operations are to be carried out in one single chucking, the self centring chuck is ideal. Contrary to the belief held by many engineers, these chucks are not intended to operate 'dead true'. Although work is sometimes set up quite accurately by this method of workholding, any such exactitude is unanticipated and concentric accuracy of 0.076mm (0.003in.) at 25mm overhang is considered good while 0.127mm (0.005in.) is often the case, especially if any wear has taken place.

If these chucks were intended to provide the benefit of exact concentricity, chucks such as the 3-jaw combination chuck introduced by Pratts of Halifax, West Yorkshire, - a particular type of 3-jaw chuck where the jaws can be accurately adjusted individually prior to being manipulated simultaneously in the usual way - would not have been developed. You can walk into almost any engineering jobbing shop and see 3-jaw chucks which have a 'fairly circle' of punch dots around one of the 3 pinion square drives where the chuck key is located. Presumably by using only this pinion to tighten the chuck, greater accuracy is possible than would be the case if the scroll is rotated by one of the other two pinions.

The component parts of a 6in. Griptru chuck. They are identical to a standard 3 jaw chuck, with the exception of the three conical wedge screws below the geared spiral ring on the left of the picture.



The year 1954 saw the introduction - by chuck manufacturers F. Burnard & Co. Ltd, then of Kidbrooke, London - (now incorporated within Pratt Burnerd International of Halifax) of a micro-adjustable 3-jaw, geared scroll chuck having the facility of adjusting the concentric location of the chuck unit relative to its mounting on the lathe spindle. That is to say that when the chuck has been secured to the spindle nose of the machine, it can then be accurately adjusted so as to become precisely concentric with the spindle. This feature bestows the chuck with the provision to be set up to within 0.005mm (0.0002in.) needle movement on the dial indicator, correcting the accumulated error of the individual parts when assembled, or compensating for any inaccuracy which may have occurred through reasonable wear and tear of the chuck. This product was named the *Griptru* chuck.

Even in 1954 the concept of moving the chuck slightly once it had been mounted was nothing new. In its simplest form the back plate or adaptor plate which is normally located to the chuck body by a precise fitting spigot register is, instead, provided with a small clearance which allows the body to be tapped true before the securing screws have been finally tightened (**fig.1**). The most conspicuous disadvantage with this method is, of course, in the fact that the body can move on the spigot when in use due to the forces present during its operation.

The Griptru chuck is, however, something different. Once set up and secured in position, there is no possibility of the chuck body moving on the spigot register and the device remains an accurate unit throughout its use. The principle of this chuck is fundamentally the same as that shown in **fig.1** except that the body is not tapped true with a mallet but is

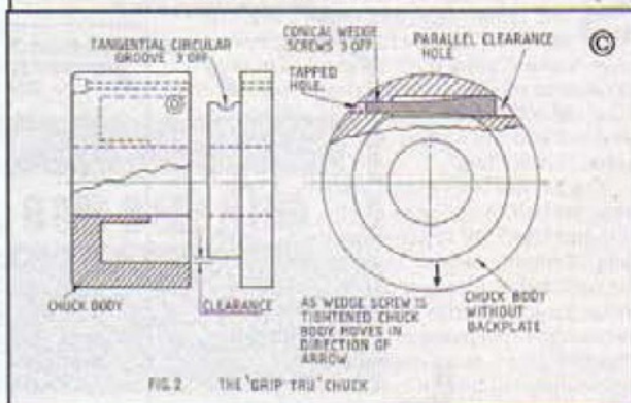
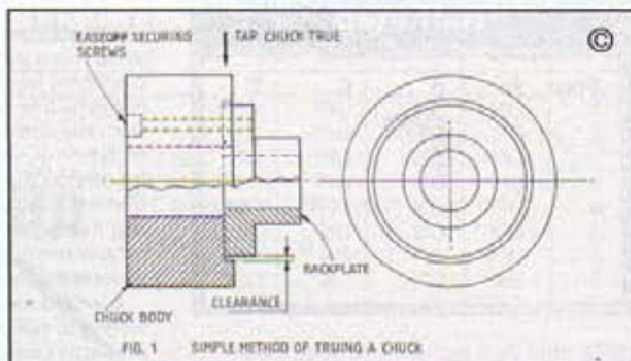
adjusted by means of 3 conical wedge screws which have hexagonal socket heads and so are moved using an Allen key. The chucks are originally supplied with the appropriate hexagon key machined onto one end of the chuck key tommy bar, an additional feature of this product.

The register spigot is machined with 3 tangential circular grooves which are milled in, equi-spaced, and form the bearing surfaces for the screw wedges (**fig.2**). These in turn are located in holes which are drilled tangentially in the body. The screws have conical shanks so that when they are screwed inwards they displace the body in relation to the adaptor plate. This is done with the tension on the securing screws relaxed. The movement of the chuck body is so slight when the conical screws are turned that the adjustment is very fine and perfectly within the control of the operator. Once he is satisfied with the truth of the chuck the securing screws are finally tightened.

These chucks were first supplied in 3 1/2, 4, 5 and 6in. diameters; larger sizes were introduced later, notably 8, 10 1/2 and 12 inches. They are now supplied in metric sizes and 6-jaw models are also available. A 4in. (100mm) diameter Griptru chuck has also been produced for direct mounting onto a Myford ML7 or Super 7 lathe.

While these chucks are quite expensive to purchase new, due to the fact that they have been on the market for 40 years or so secondhand examples are commonly found and don't seem to command a higher price than a standard 3-jaw of the same diameter and condition.

I hope that this short article will assist the home workshop enthusiast in recognising this excellent work holding device if he is fortunate enough to encounter one at a bargain price.



A COMPUTER CONTROLLED X-Y TABLE

Following Ray Stuart's article about stepper motors in the last issue, he now describes his success in applying these to an X — Y table, using a PC and CAD to control this. He has written the software to combine the three functions, table, PC and CAD, into one working system. The article commences with the full and half step sequences, which were omitted from the article in issue 26. Readers may find it useful to return to this article as a refresher before starting on this article

Full step

Step	A	B	C	D
1	ON	OFF	ON	OFF
2	OFF	ON	ON	OFF
3	OFF	ON	OFF	ON
4	ON	OFF	OFF	ON

Half step

Step	A	B	C	D
1	ON	OFF	OFF	OFF
2	ON	OFF	OFF	ON
3	OFF	OFF	OFF	ON
4	OFF	ON	OFF	ON
5	OFF	ON	OFF	OFF
6	OFF	ON	ON	OFF
7	OFF	OFF	ON	OFF
8	ON	OFF	ON	OFF

Some time ago a friend gave me an old, rather large and rather dirty, dot matrix printer he had rescued from a skip. It didn't work but he thought I might be able to use some of the more "useful bits". More junk I thought, but I still took it and put it in the garage with the all the other "useful bits".

The printer languished there for a few months before curiosity got the better of me and I decided to see what these "useful bits" it might contain. These turned out to be two rather nice stepper motors. Now what could I do with these? The question remained unanswered for a further few months when, at an engineering exhibition, I noticed a small computer controlled X-Y table. And what do you think made the table move? Yes you've

guessed; two stepper motors. "How much does it cost?" I enquired. "Several thousand pounds" came the reply, "and that's not including the computer or the software!"

I didn't have several thousand pounds, but I did have two stepper motors, and a PC and a CAD package at home. An idea began to form in my mind, I could use the CAD package to design a component and then use an X-Y table to help produce it. Several applications came to mind, including using it for marking out components, as part of a light milling machine, or a pen plotter. All I had to do was to find a way of mixing a cocktail of PC computer, CAD package and stepper motors, throw in a dash of mechanical components and, Hey Presto, one computer controlled X-Y table for considerably less than "several thousand pounds". Simple I thought, and so this project began. What actually transpired was not as simple as I first thought, but then is anything?

The result of much head scratching and even more burning of midnight oil is presented here; a computer controlled X-Y table. The project can be divided into three main parts; the stepper motor drive system, the table mechanics and the software required to convert the CAD package data to a form understood by the stepper motors. Let's start by considering the stepper motor drive system.

The stepper motor drive system

The stepper motor drive system is a piece of electronic hardware that converts low power signals from the computer to a high power ones suitable for driving the stepper motors. I decided from the beginning that the design criteria would have to include the following:-

It would have to be fairly simple to build, use readily available components and,

most importantly, it would not require any modifications to the computer itself. I also wanted to be able to use different size stepper motors, to allow for future applications with only minor modifications to the circuitry. Given these requirements I set about designing the stepper motor drive system described below.

Power supply

Stepper motors come in a range of sizes, those of particular interest are the 17, 23, and 34 sizes. The largest, the 34 size, requires currents of around 3 or 4 amps per phase, with each motor having up to two of its four phases energised at any one time. As the system controls two motors, the power supply has to supply around 12 amps.

The system doesn't require a very stable voltage, so the power supply is fairly simple. The design (Fig. 1) is based on a centre tapped transformer, two diodes, D1 and D2, to rectify it's AC output, and a capacitor C1 to smooth the voltage. Diodes D1 and D2 need to conduct up to 12 amps each, so 16 amp stud types are used. These are mounted on a heat sink for reliability and as the means of connecting the two cathodes together. It is therefore important to ensure that the heat sink is isolated from other parts of the circuit, as it is at a potential of 12 volts.

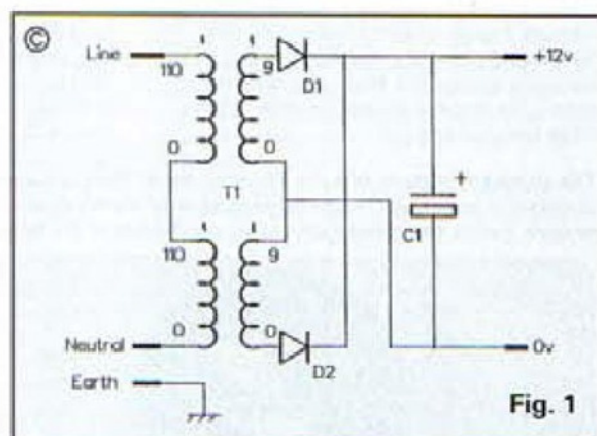


Fig. 1

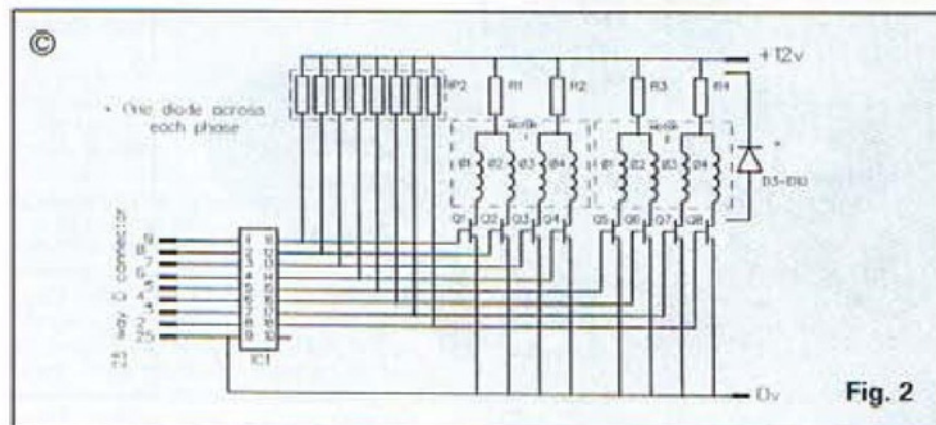
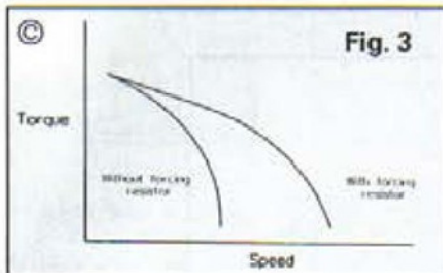


Fig. 2



Motor drive circuit

A number of integrated circuits, specifically designed to control stepper motors, are commercially available. However, these tend to have a maximum drive capacity of around 1 amp per phase, clearly insufficient for this application. I could of course add current drivers to the integrated circuit's output, but a simpler method is to use the drivers only and allow the computer to generate the step sequence. (The theory of operation of stepper motors was described in *Model Engineers' Workshop* No.26 page 61).

The PC's parallel port provides eight output lines, a convenient number given that we have to control two stepper motors each with four phases. In addition, the parallel port also has a number of inputs, four of which are used to monitor limit switches on both axis, I will return to these later.

The drive circuit is shown in **Fig. 2**. The eight drive lines from the computer switch between 0 and 5 volts. However, to adequately drive the output FETs (field effect transistors), Q1 - Q8, a higher voltage is required; 12 volts in this case. This is achieved by using IC1, an octal Darlington transistor driver. The outputs of IC1's Darlington transistors are connected to the

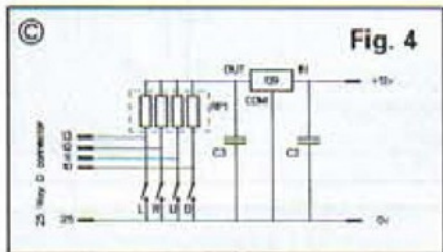
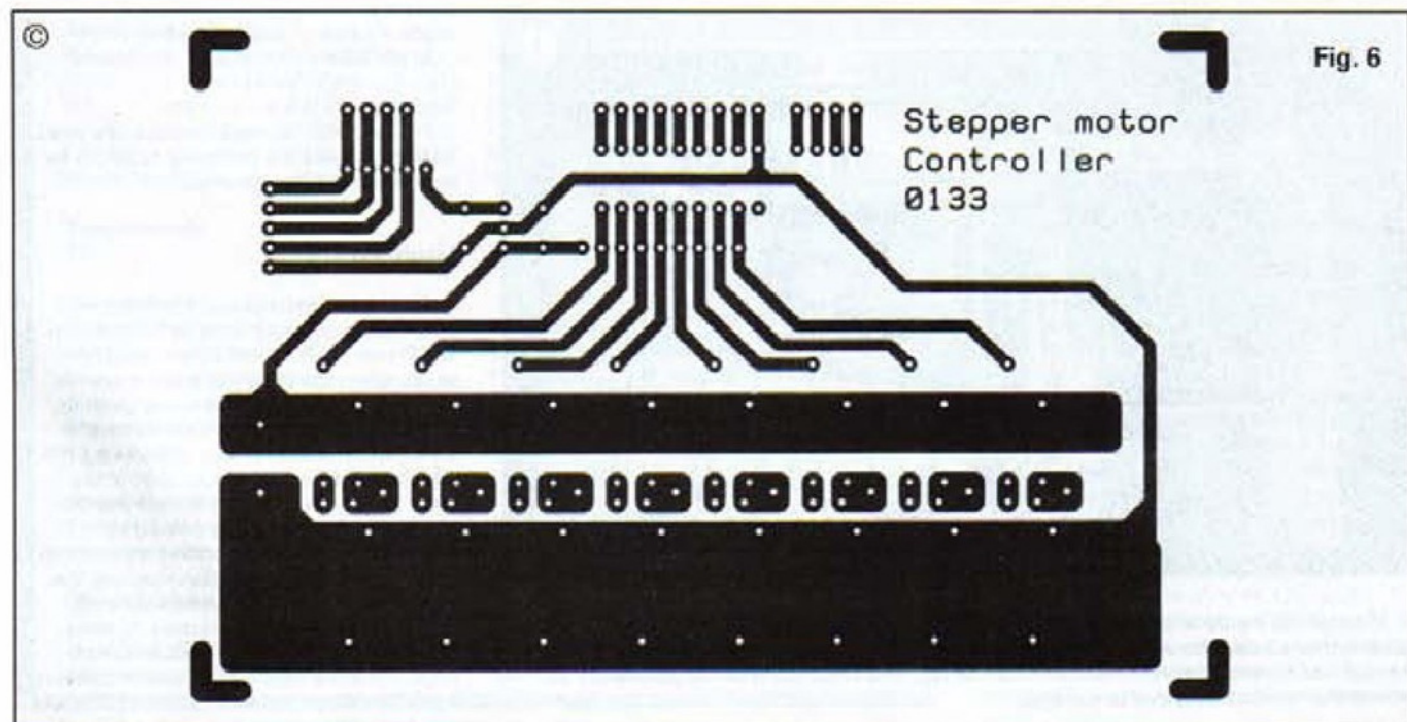
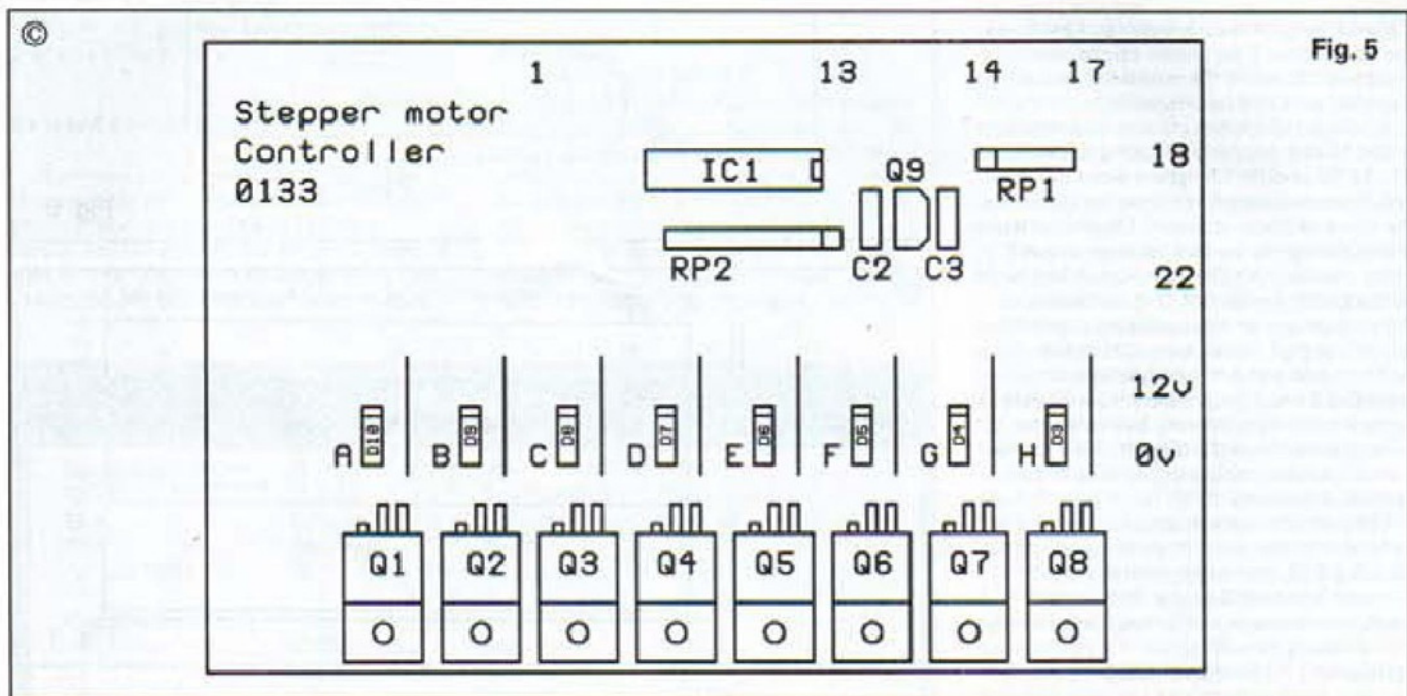


Table 1
Table of preferred resistor values for some Electromail stepper motors.

Type	Resistor
17 (440-420)	15Ω
23 (332-082)	10Ω
34 (344-631)	6.8Ω



12 volt line by the 1k Ω resistors in RP2. The type of FET employed in this design, the IRF540, is capable of switching around 20 amps each. Even though they are not operating anywhere near their limit they are mounted on a heat sink to provide added reliability, and allow larger stepper motors to be used at a later date if required.

The stepper motor phase windings are inductively wound and, when switched off, can generate high voltages in much the same way as does a car's HT coil. In the car this is a very useful property, it makes the ignition system work, but in our case the voltage could destroy the FETs. To prevent this diodes D3 to D10 are included to restrict this voltage to acceptable limits.

The action of the circuit is such that if 5 volts (logic "1") is applied to an input of IC1, the Darlington transistor switches on and 0 volts is supplied to the FET's control terminal, called the gate. When 0 volts (logic "0") is applied, the Darlington turns off, and the gate is connected to 12 volt via the 1k resistor. Thus motor phases are switched ON when the computer output is logic "0" and OFF by a logic "1".

Each pair of motor phases is connected to the 12 volt supply by limiting resistors R1, R2, R3 and R4. Different size motors can be accommodated simply by changing the value of these resistors. Given that the phase voltage is usually between 3 and 5 volts, you may well ask why use a higher voltage and the current limiting resistors, rather than use an appropriately sized power supply? The answer is that this technique of using "forcing resistors" provided a much improved torque/speed curve than driving directly from a lower voltage power supply, (Fig. 3). This allows a wider range of operating speeds to be usefully employed.

The resistors are selected for the particular motor used. For example, consider a 34 size motor with a phase rating of 3 volts at 3 amps. The resistor value, and wattage can be calculated using the following formulae:-

Resistance = (12 - phase voltage) $\div$ phase

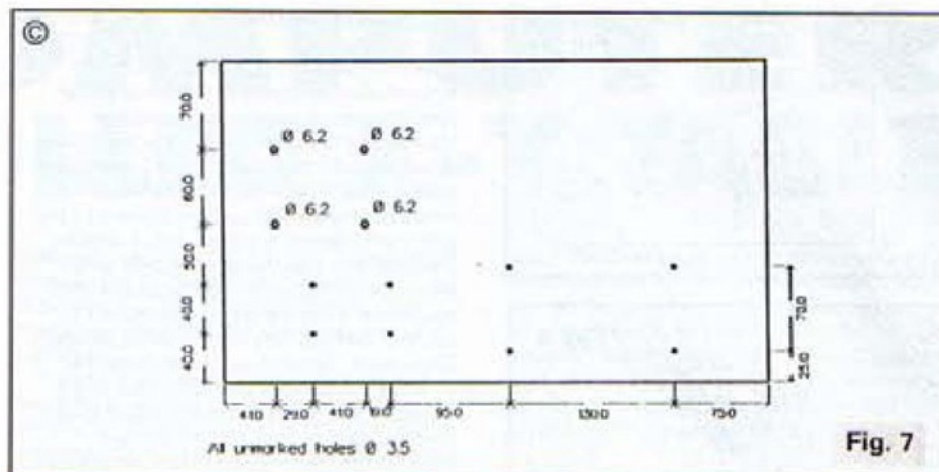


Fig. 7

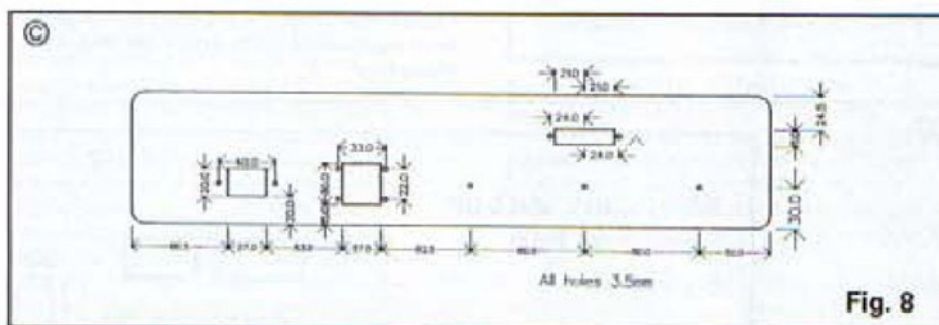


Fig. 8

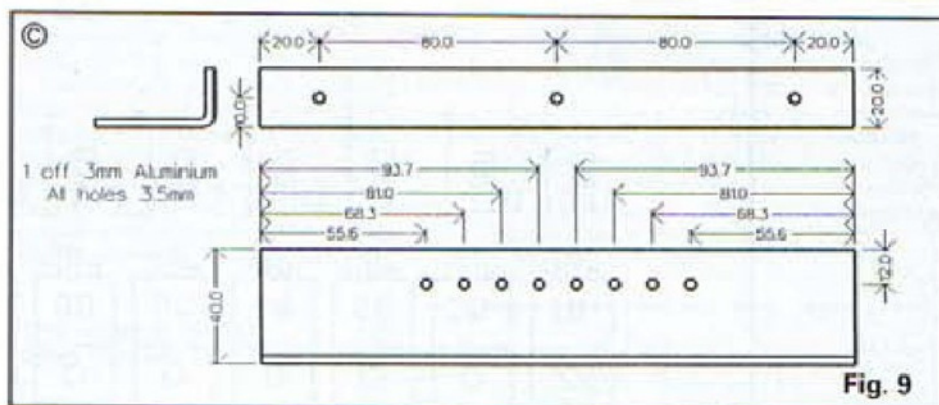
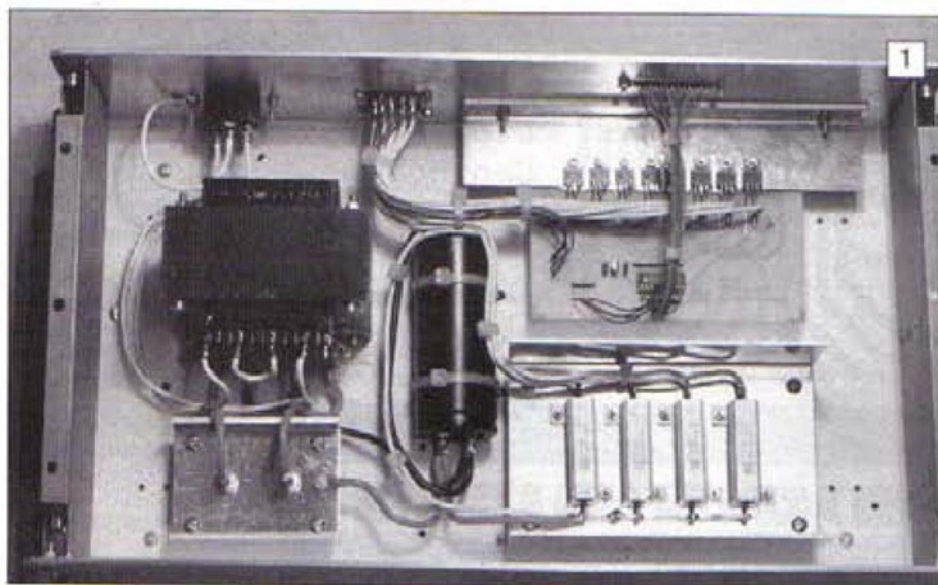


Fig. 9



1: View of the inside of the control equipment. It is probable that you will want to make tests of the electronics while it is alive. In view of this, a simple shroud over the main socket and transformer terminals must be fitted. This will minimise the possibility of accidental contact with mains voltages.

current Ω

Watts = current² x resistance

In the above example Resistance = (12 - 3) $\div$ 3 = 9 $\div$ 3 = 3 Ω and Wattage = 3 x 3 x 3 = 27 watts.

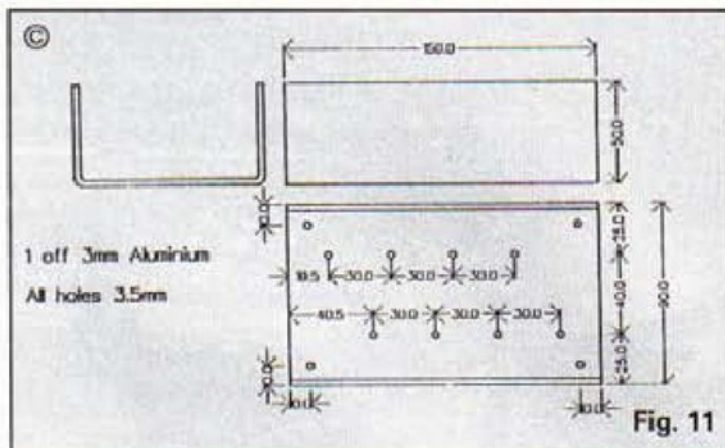
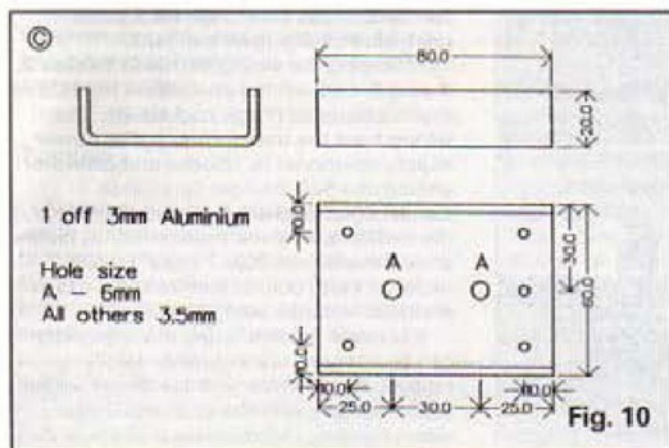
For reliability 50 watt resistors are used.

Table 1 shows the preferred resistors for a selection of stepper motors.

Limit switches

To prevent mechanical overload, four limit switches, designated Left, Right, Up and Down, (L, R, U and D) are used to sense when the table has been driven to its extremities. They also serve another, important purpose. When the system is switched on it has no way of knowing the table's absolute position, so part of the initialisation process is to determine the system's origin. This is achieved by moving the table to a position where both left and down limit switches operate, the reference origin for further operations.

The power supply generates 12 volts, however, the computer requires only 5 volts. Thus the limit switch circuit contains its own voltage regulator Q9, a 78L05, and two smoothing capacitors, C2 and C3. One



end of each switch is connected to 0 volts and the other to 5 volts via 1K Ω resistors in RP1 (Fig. 4). The switches are normally open, that is to say the output is logic "1" until a limit is reached whereupon it changes to logic "0".

Printed circuit board

A printed circuit board (PCB) has been designed for all components except those of the power supply. The component layout and foil pattern are shown in Figs. 5 and 6. The PCB has been designed to bolt directly to the FET heat sink which is itself

bolted to the back panel. Table 2 lists the components for the stepper motor drive system.

Assembly

The system was designed to fit inside a case rescued from a previous project. The layout is not critical and any suitably sized case may be used, however, it is recommended that the heat sink sizes are retained as shown.

The first stage is to machine the base and back plates as shown in Figs. 7 and 8. Next manufacture the heat sinks for the

FETs, diodes and resistors; all of which are made from 3mm aluminium sheet as shown in Figs. 9, 10 and 11. The latter two are mounted to the base of the case using any suitable insulated pillars. I used commercially available pillars, made of nylon and fitted with M3 threaded inserts. Mount the diodes and resistors on their respective heat sinks and mount these, together with the transformer, on the base plate as shown in Fig. 12. Follow this by mounting the various plugs and sockets on the back panel.

The next task is to assemble the PCB. It is worth using a socket for IC1, this prevents damage due to overheating while soldering and allows it to be changed easily should the need arise. Solder the socket in position and use this as a landmark for the other components. Now solder in the two resistor packs, it should be noted that these must be fitted the correct way round; the common end is identified by a dot which corresponds to the bar in Fig. 5. Insert diodes D3 to D10, ensuring that these too are installed the correct way round, again refer to Fig. 5. The voltage regulator, Q9, and the two capacitors C2 and C3, can now be installed followed by the eight 22 swg tinned copper wire links. Next insert IC1 ensuring that it is oriented as shown in Fig 5. Using two M3 screws and nuts, fix the PCB to the FET heat sink using the outer two holes, the heat sink should be on the top (component side) of the PCB.

The next stage is to mount the FETs in position. These must be electrically insulated from the heat sink by means of mica washers and small plastic sleeves as shown in Fig. 13. Carefully bend the FET legs so that they pass through the holes in the PCB and fix the FET in position using M3 screws and nuts. Before finally tightening the screws and soldering in place, check that the mica washer and sleeve are correctly positioned. When the inner six FETs have been installed remove the M3 screws and nuts from the outer two positions and insert the remaining two FETs.

You should now solder the connecting wires to the board before fixing the whole assembly to the back panel. For the signal leads, (i.e. those that go to pads 5 to 22 on the PCB), use 10/0.1 single core cable, 32/0.2 single core for A to H, 12v, and 50/0.2 for 0v. It is better to make these longer than actually required as it is easier to shorten them later but considerably more difficult to lengthen. When complete,

Table 2

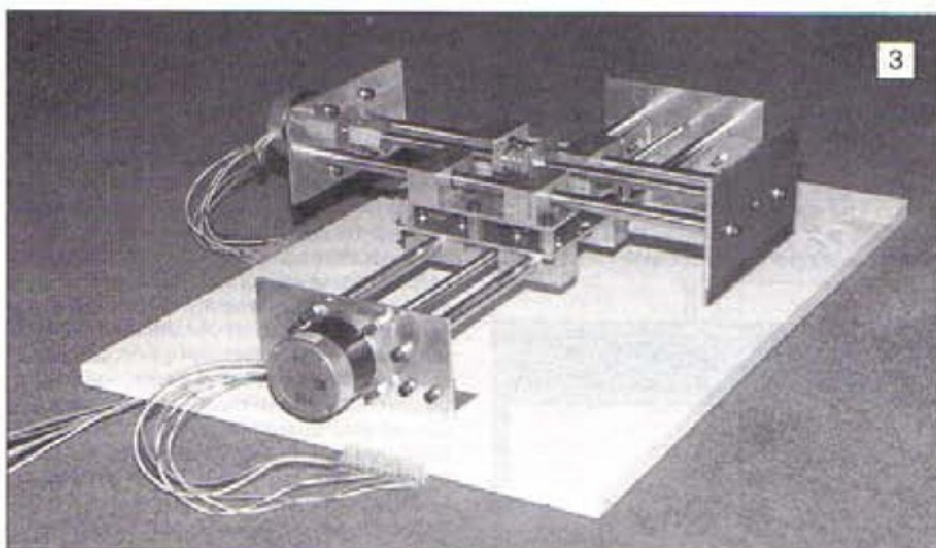
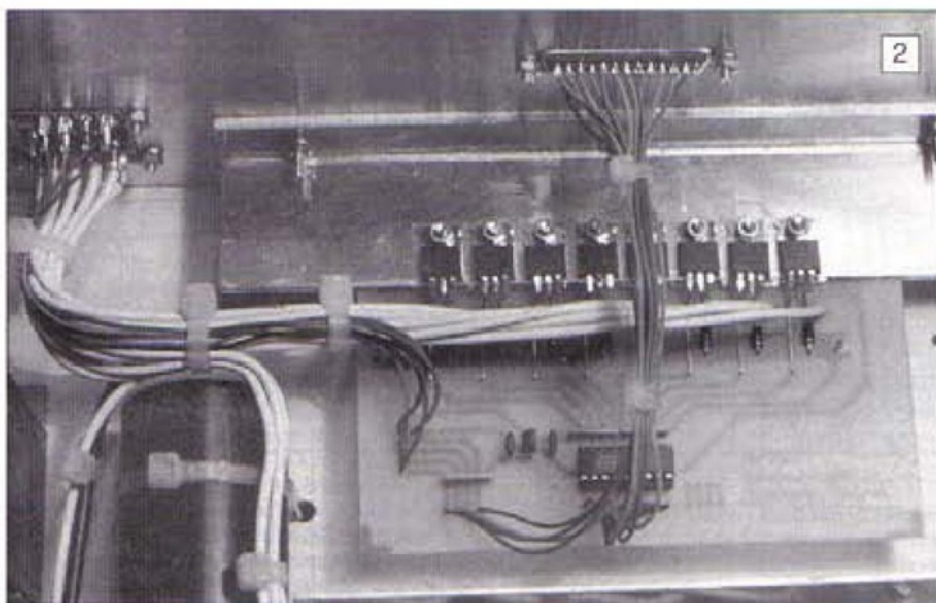
Resistors			
R1-4*	50 watt	Electromail	* See text
RP1	4x1k pack	Farnell	107-058
RP2	8x1k pack	Farnell	219-150
For test LEDs	1k	Maplin	M1K0
Capacitors			
C1	47000 μ F 25 v	Maplin	JL60Q
C2	0.1 μ F	Maplin	YY11M
C3	0.1 μ F	Maplin	YY11M
Semiconductors			
IC1	ULN2803A	Maplin	QY79L
Q1-8	IRF540	Maplin	UR43V
Q9	78L05	Maplin	QL26D
D1-2	16F10	Farnell	16F10
D3-10	IN4001	Maplin	QL73Q
Motor test LEDs	Maplin	WL27E	
Transformer			
T1	9-0-9 200 watt	Farnell	177-212
Connectors			
25 way D series male		Maplin	YQ48C
Motor connector plug		Electromail	466-040
Motor connector socket		Electromail	466-084
Motor connector cover		Electromail	466-129
Mains connector		Maplin	HL15R
25 way lead		Maplin	JC13P

Stepper motors

Various types are available from a range of suppliers, e.g. Electromail. Consult manufacturers catalogues for full details.

Miscellaneous

Case	Style 2	Electromail	581-098
Insulated pillars (20mm)		Maplin	FS38R
Mica washer/sleeve kit		Farnell	170-016



2: Close-up of the PCB, together with the heatsink assembly, mounted with FET's for supplying power to the stepper motors.

3: The X-Y table. Another photograph of this is on the cover, showing a close-up of the main central assembly.

fix the FET heat sink to the back panel using three M3 screws and nuts.

Following the wiring details in **Tables 3, 4 and 5**, connect the wires from the PCB to their designated plugs, sockets etc. The wiring from the transformer to the power supply components, (diodes and capacitor) should use 50/0.2 single core cable. Connections between the motor socket and the resistors, and the transformer to mains socket should use 32/0.2 cable. Finally, make an earth connection from the mains socket to the case using 32/0.2 cable.

It is worth remembering that electricity can be dangerous if not treated with respect, so take care with the mains wiring and especially with the earthing. If you choose to use a plastic case make sure that all external metal panels are bonded to earth. Before you connect to the mains take a careful look at the wiring and double check that all the connections go where

Table 3
20 bay plug connections to motors

Pin	Function
1	Left limit switch
2	Right limit switch
3	Up limit switch
4	Down limit switch
5	Limit switches 0 volt
6	No connection
7	No connection
8	No connection
9	Motor 1 - phase 1
10	Motor 1 - phase 2
11	Motor 1 - phase 3
12	Motor 1 - phase 4
13	Motor 2 - phase 1
14	Motor 2 - phase 2
15	Motor 2 - phase 3
16	Motor 2 - phase 4
17	Motor 1 - phase 1/2 common
18	Motor 1 - phase 3/4 common
19	Motor 2 - phase 1/2 common
20	Motor 2 - phase 3/4 common

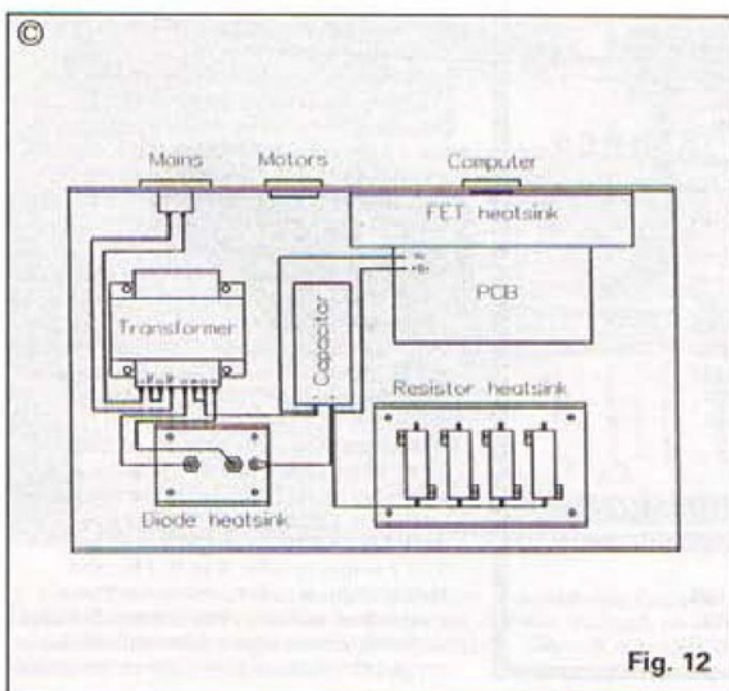


Fig. 12

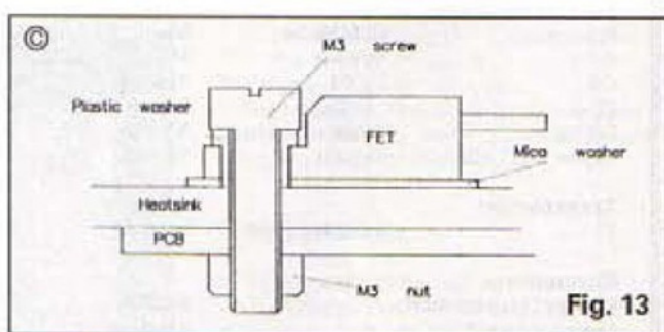


Fig. 13

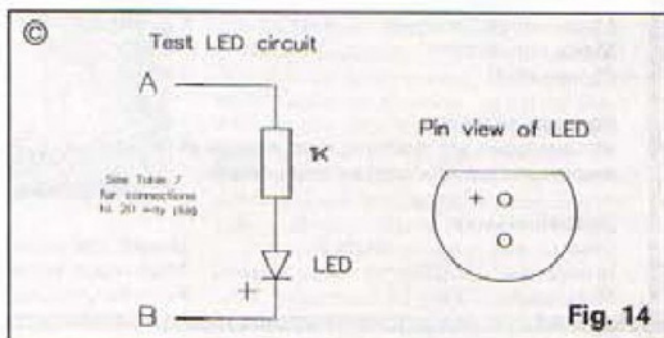


Fig. 14

they should, and that there are no shorts between pins. It is well worth spending a few moments checking as it can save time, and money, later.

Testing

Now that you've built the system its worth undertaking a few simple tests before connecting it to your computer and stepper motors. First connect the mains and measure the voltage across the power supply capacitor C1, the value should be

around 12 volts DC. Next measure the voltage across capacitor C3, which should be 5 volts DC. If all is well switch off before testing further.

Having established that the power supply circuit is functional, the next stage is to check that the FETs are switching. This can be checked by connecting small LEDs in place of the stepper motor phase coils. This is best achieved by soldering the LEDs directly on the motor output plug as indicated in **Fig. 14** and **Table 7**.

With the LEDs fitted switch on the mains and all LEDs should turn ON. Take a length

of 10/0.1 wire and strip and tin both ends. Connect one end to the positive end of C1 (12 volt) and put the other on pin 2 of the 25 way D series plug. The result should be that one of the LEDs will turn OFF. Now remove the wire from pin 2, (all LEDs will turn ON again), and place it on pin 3; this time another LED will turn OFF. Repeat this procedure for pins 4 to 10 on the 25 way D series connector. Now that all the FETs have been tested the stepper motors can be soldered to the plug, as shown in **Table 6**, but switch the mains off first.

Connect the stepper motor drive unit to the computer's parallel port using a 25 way male to 25 way female cable. This is arranged with pin 1 at one end connected to pin 1 at the other, pin 2 to pin 2 and so on to pin 25. Cables are readily available at reasonable cost and it is well worth considering purchasing one.

Test Software

To test further it is necessary to run some software on the computer. The short programme, called **Steptest**, is listed below (Programme 1). It is written in Turbo Basic and allows both stepper motors to run continuously in one direction. Many readers will be familiar with other versions

Programme 1 STEPPER MOTOR DRIVE TEST ROUTINE Filename: STEPTEST.BAS

```
'THIS ROUTINE WILL ROTATE TWO
'STEPPER MOTORS, CONTINUOUSLY
'IN THE SAME DIRECTION THE
'PROGRAMME USES THE PC PARALLEL
'PORT AT I/O ADDRESS 378 HEX (LPT1).
'CLS CLEAR THE SCREEN
PRINT " STEPPER MOTOR TEST"
DIM MOTOR2(8)
'SET UP STEP SEQUENCE FOR HALF
'STEP MODE
'AS AN ARRAY. NOTE THE BIT PATTERN
IS INVERTED
'BY THE XOR FUNCTION DUE TO THE
'INVERTING NATURE
'OF THE DRIVE CIRCUITRY.
```

```
MOTOR2(1) = &H99 XOR &HFF
MOTOR2(2) = &H88 XOR &HFF
MOTOR2(3) = &HAA XOR &HFF
MOTOR2(4) = &H22 XOR &HFF
MOTOR2(5) = &H66 XOR &HFF
MOTOR2(6) = &H44 XOR &HFF
MOTOR2(7) = &H55 XOR &HFF
MOTOR2(8) = &H11 XOR &HFF
```

```
START:
CALL MotorStep(I%,MOTOR2(I))
INCR I%
GOTO START
END
SUB MotorStep(I%,MOTOR2(8))
'THIS IS THE SUBROUTINE TO SELECT
'THE NEXT BIT PATTERN
IF I%=9 THEN I%=1
'USED WHEN COUNTING UP
IF I%=0 THEN I%=8
'USED WHEN COUNTING DOWN
OUT &H378, MOTOR2(I%)
'SEND DATA TO PARALLEL PORT
DELAY 0.01
END SUB
```

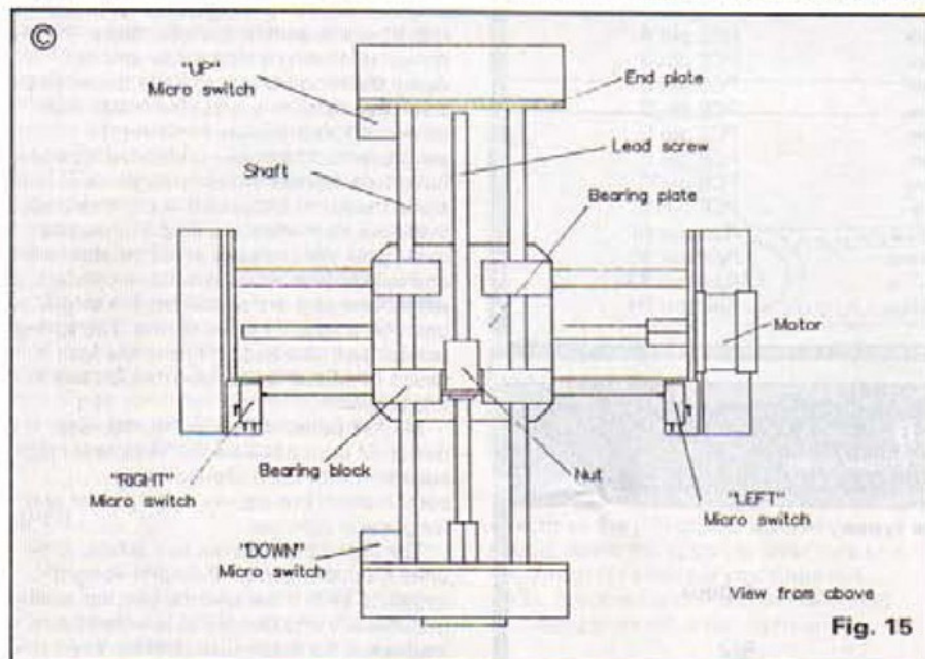


Table 4
PCB connections

Pin	Function	Connect to
1	No connection	
2	No connection	
3	No connection	
4	No connection	
5	0v	25 way plug pin 25
6	Motor 1 phase 1 control signal	25 way plug pin 2
7	Motor 1 phase 2 control signal	25 way plug pin 3
8	Motor 1 phase 3 control signal	25 way plug pin 4
9	Motor 1 phase 4 control signal	25 way plug pin 5
10	Motor 2 phase 1 control signal	25 way plug pin 6
11	Motor 2 phase 2 control signal	25 way plug pin 7
12	Motor 2 phase 3 control signal	25 way plug pin 8
13	Motor 2 phase 4 control signal	25 way plug pin 9
14	Left limit switch	25 way plug pin 10
15	Right limit switch	25 way plug pin 11
16	Up limit switch	25 way plug pin 12
17	Down limit switch	25 way plug pin 13
18	Down limit switch	20 way socket pin 4
19	Up limit switch	20 way socket pin 3
20	Right limit switch	20 way socket pin 2
21	Left limit switch	20 way socket pin 1
22	0v	20 way socket pin 5
12v	12 volt supply	Capacitor C1 +ve
0v	0 volt supply	Capacitor C1 -ve
A	Motor 1 phase 1 drive	20 way socket pin 13
B	Motor 1 phase 2 drive	20 way socket pin 14
C	Motor 1 phase 3 drive	20 way socket pin 15
D	Motor 1 phase 4 drive	20 way socket pin 16
E	Motor 2 phase 1 drive	20 way socket pin 9
F	Motor 2 phase 2 drive	20 way socket pin 10
G	Motor 2 phase 3 drive	20 way socket pin 11
H	Motor 2 phase 4 drive	20 way socket pin 12

Table 5

20 way socket connections

Pin	Function	Connect to
1	Left limit switch	PCB pin 21
2	Right limit switch	PCB pin 20
3	Up limit switch	PCB pin 19
4	Down limit switch	PCB pin 18
5	Limit switches 0v	PCB pin 22
6	No connection	
7	No connection	
8	No connection	
9	Motor 1 phase 4 drive	PCB pin A
10	Motor 1 phase 3 drive	PCB pin B
11	Motor 1 phase 2 drive	PCB pin C
12	Motor 1 phase 1 drive	PCB pin D
13	Motor 2 phase 4 drive	PCB pin E
14	Motor 2 phase 3 drive	PCB pin F
15	Motor 2 phase 2 drive	PCB pin G
16	Motor 2 phase 1 drive	PCB pin H
17	Motor 1 phase 1/2 drive	Resistor R1
18	Motor 1 phase 3/4 drive	Resistor R2
19	Motor 2 phase 1/2 drive	Resistor R3
20	Motor 2 phase 3/4 drive	Resistor R4

Table 6

Stepper motor cable colour code

6 Wire types	
Function	Colour
Phase 1	Red
Phase 2	Red/white
Phase 3	Green
Phase 4	Green/white
Phase 1/2 common	Black
Phase 3/4 common	white
8 Wire types	
Function	Colour
Phase 1	Black
Phase 2	Orange
Phase 3	Red
Phase 4	Yellow
Phase 1/2 common	white/black and white/orange
Phase 3/4 common	Red/white and Yellow/white

of Basic, for example Quick Basic and BBC Basic, however, there are subtle differences between these and Turbo Basic. The most obvious is apparent by looking at the programme below. Turbo Basic does not require line numbers. The second is that Turbo Basic is compiled whereas most other Basics are interpreted. The significance of this is that, once compiled, Turbo Basic programmes can be run on their own, and can therefore be used by any PC whether or not it contains Basic. To run Steptest put the floppy disk in the PC's drive A and type A:STEPTST. Then hit the Enter key. Now that we have built the stepper motor drive system, let us look at the table mechanics.

Table mechanics

There are a number of options available when considering the design of an X-Y table. Like most things in engineering, the final design is always a compromise between a number of conflicting criteria, including the application, availability of components and their cost. At this point it is worth considering the options available.

In order to achieve high accuracy it is important to eliminate slop in bearings and backlash in the drive mechanism. The robotics industry is faced with exactly the same requirements and, not surprisingly, a number of components have been developed. To eliminate any play in

bearings a type of ball bearing has been developed called the linear ball bushing, a bearing that slides along a precision ground shaft. It is similar to the conventional ball bearing except that the balls run between the bushing and the shaft. They move from one end of the bushing to the other as the bushing moves along the shaft. When at the end they are recycled back to the beginning. The disadvantage of these is their cost, a single bush can cost something in the region of £30 and precision ground shafts are not cheap either.

Like a lathe or milling machine, linear movement is translated from rotary movement using a lead screw and nut. Again the robotics industry has developed a suitable system, a precision made lead screw and an associated ball nut. To eliminate backlash, two preloaded nuts are fitted back to back within a single case, and again these are expensive. A commercially available alternative is a plastic moulded nut. These are available at reasonable cost and available in an anti-backlash version where two nuts are contained in a single unit and loaded by a coil spring. The spring tension can be adjusted to suit the load it has to handle. It is this type that is used in this project.

My X-Y table, shown in Fig. 15, was designed primarily as a test vehicle for the stepper motor controller/software combination, but also as a pen plotter and for general light use.

The assembly consists of two similar slide units mounted one on the other at right angles to each other and the pen, (or tool) is stationary and located above the X axis lead screw for maximum stability. My design criteria was that it had to be reasonably cheap and easy to build, (remember it was intended as a prototype), but would be able to exhibit acceptable accuracy. However, as mentioned above the commercially available options normally associated with robotics were considered too expensive for this application, with eight linear bearings being required, I decided to look for alternative solutions.

The option I finally decided on was to use 12mm silver steel shafts located 80mm apart and use Oilite bushes for the bearings. Although these are considerably cheaper than linear ball bushings and precision ground shafts, the resulting arrangement has proved more than adequate for my applications. As the accuracy depends on the quality of the lead screw/nut arrangement I decided to use commercially produced plastic moulded units as described above. After searching through numerous manufacturer's catalogues I found a company that could supply both trapezoidal form lead screws and moulded plastic nuts at reasonable cost. The lead screws in this design are connected directly to the stepper motor output shaft. As my workshop facilities are very limited, the endplates and bearing plates were made from 3mm sheet aluminium, the brackets fashioned from 40mm x 3mm aluminium angle, and the Oilite bushes fitted into blocks made from 25mm x 25mm aluminium. These blocks were then individually bolted onto the bearing plates, a technique that allowed them to be easily adjusted to ensure that the shafts run parallel.

Micro switches are mounted at either end of both axes and are used to set the origin and act as limit detectors to prevent damaging the system. **Table 8** list suppliers of the various components suitable for use in X-Y Tables.

CAD Systems, HPGL & XYTL

Before we discuss the software required to translate between Computer Aided Drawing (CAD) packages and the stepper motors, let us consider the nature of a typical CAD package. Different CAD packages use different techniques to store the diagrams, and none are directly capable of driving my stepper motors. What is needed is some technique common to all packages. Fortunately this is not as difficult to find as you might expect. All CAD packages have the facility to drive a pen plotter to produce hard copy diagrams. Like CAD packages pen plotters are available from a range of makers, but one common standard has been adopted by the majority of these. This was developed by a company called Hewlett Packard for their own range of pen plotters; it proved so successful that it was adopted by virtually all other pen plotter manufacturers. It is known as "Hewlett Packard Graphic Language" or HPGL for short.

HPGL

Although not essential, it is useful if the reader has an appreciation of HPGL. There are some tens of HPGL commands, but only two concern us. These are the most commonly used commands, "PU" (pen up) and "PD" (pen down). A typical command might be PU200,300. This instructs the plotter to put the pen in the up position and then move in a straight line from the current position to a position where X=200 HPGL units and Y=300 HPGL units from the plotter's origin.

But what, you may ask, is an HPGL unit? One HPGL unit is defined as being 0.025mm. Therefore the required position identified in PU200,300 is: X=0.025 x 200 = 5mm and Y=0.025 x 300 = 7.5mm. Similarly PD200,300 would move the pen to the same position, but this time with the pen down thereby drawing a line.

However, HPGL is not capable of directly driving the stepper motor controller, what we need is to take this standard and use it to as the basis for the our needs. The software developed for the X-Y Table has been designed to convert HPGL to a form understood by the stepper motor control unit previously described; let's call this XYTL for (X-Y Table Language).

On my X-Y Table the lead screw has a pitch of 2mm and, with 400 steps per revolution of the stepper motor, the linear movement equates to 0.005mm or 1 XYTL unit. Thus for my table 1 HPGL unit = 0.025 ÷ 0.005 = 5 XYTL units.

CAD package set-up

CAD packages have a facility to install a plotter driver associated with the plotter it will use. For use with the software described below you should install a printer driver for the Hewlett Packard HP7470 plotter.

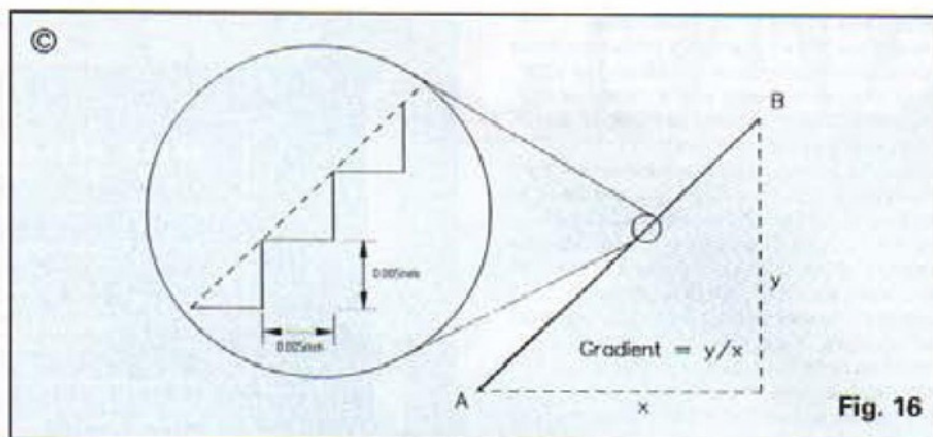


Fig. 16

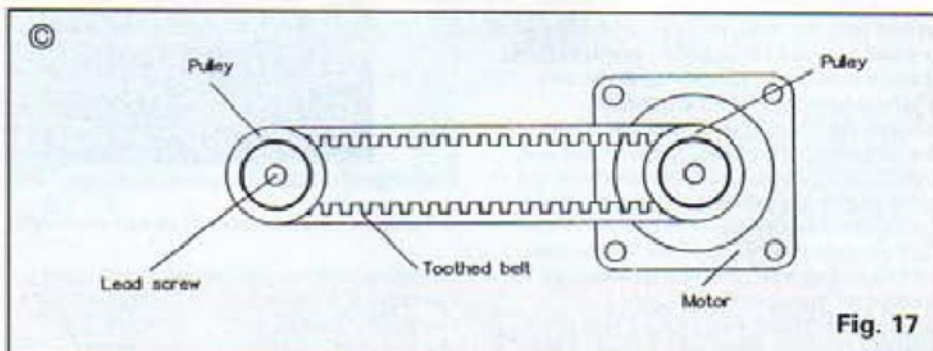


Fig. 17

Normally the CAD package sends data directly to the plotter, but instead you should select the option to send data to a file, which for example you could call XYTL. It is this file that will be translated into stepper motor drive commands.

The software package

Now that we have a table, the stepper motors, a drive unit and a HPGL file we need a software package to integrate them. The package, called **XYTABLE**, was written in Turbo Basic specifically for this project and is designed to run on a PC. XYTABLE is available on floppy disc together with the test programme STEPTEST mentioned above and a sample HPGL file called XYTL.

Interesting though it may be for some, *Model Engineers' Workshop* is not the place to enter into a lengthy and detailed discussion of the detailed workings of the software, nor is it the place for a full

software listing amounting to some 15 A4 pages. However, a brief description of the operation is warranted.

The first operation the software undertakes is to set the table's origin or zero position (X=0, Y=0). This is achieved by driving the X stepper motor until the "Left" micro switch is operated and then reversing the stepper motor for two turns of the lead screw in order to clear the limit switch. The Y stepper motor then undergoes a similar process, but this time the "Down" microswitch is monitored.

When the origin has been established, the data entry screen (**Photo 4**) is displayed allowing the reader to enter data relating to their particular system. It asks for the HPGL file to be processed, whether Metric or Imperial units are to be used, the pitch of the lead screw, and asks if the entered data is correct. If so the second screen, is displayed. This indicates the current and required X-Y positions, whether the pen, (or tool), is up or down, the current HPGL command and the

Table 7
Test LED connections

FET to be tested	Connect A to pin on 20 way plug	Connect B to pin on 20 way plug	Test lead to Pin on 25 way plug
Q1	9	17	2
Q2	10	17	3
Q3	11	18	4
Q4	12	18	5
Q5	13	19	6
Q6	14	19	7
Q7	15	20	8
Q8	16	20	9

Note: other end of test lead connected to 12 volts

percentage of the HPGL commands completed. When there is a transition from a pen up to a pen down command or vice versa, the motors stop and a message is displayed to indicate that the pen or tool position should be changed.

Now let us examine the mechanism by which the table is moved from one point to another. Consider the movement from point A to point B as shown in Fig. 16. The gradient of the line is $y \div x$ and it is this ratio from which the relative stepping speeds of the two stepper motors are derived. For example, if y is twice x , the Y motor would have to move two steps for every single step of the X motor. If, on the other hand, y was half x , the X motor would undergo two steps for every Y step.

The software keeps a record of the current pen, (or tool), position and when it receives the next HPGL command it knows where it was and where it has to go, and can therefore calculate the gradient between the current and required points. The software then moves the X motor one step and calculates, using the gradient, the corresponding Y position. If the change in Y is greater than or equal to one XYTL unit the Y stepper motor is advanced one step and the difference between the required Y position and the new Y position recalculated. The Y step sequence is repeated until the difference between the required Y position and the actual Y position is less than one XYTL unit.

The software tests to see if the new X position is within one XYTL unit of the required X position and if not the X motor is moved one step and the above Y motor sequence repeated. This procedure is repeated until the required X and Y position, as defined by the current HPGL command, is reached. The next HPGL command is read and the whole sequence repeated and so on until all the commands have been processed. Should the software attempt to drive the table outside its movement envelope, the micro switch will be activated and the motor(s) stopped.

The stepper motor drive unit should be connected to the computer's parallel (printer) port LPT1 using the 25 way cable. To run the software, place the floppy disc in the computer's A drive and type A:XYTABLE, then hit the Enter key.

Adapting the system to existing equipment

Although the system was designed to work with the X-Y Table described above there is no reason why it could not work with any other design of table. If you have an existing X-Y table and you wish to add computer control there are a number of techniques that might be employed. The simplest, and arguably the best, method is to directly couple the stepper motor shaft to the lead screw, as is the case on my table, and possibly for milling machine tables. This method eliminates any backlash between the motor and the lead screw that might occur if spur gears are used.

It is however recognised that this arrangement may not be feasible where space is at a premium. An alternative is to use toothed belts and pulleys. These have an advantage over conventional spur gears in that they are quiet in operation, are available in anti-backlash form and allow



4: Typical computer screen image provided by the software "XYTABLE"

more flexibility in positioning the stepper motor. In this situation one pulley would be mounted directly on the stepper motor shaft, and the other on the lead screw. Such an arrangement is shown in Fig. 17.

Applications and conclusions

This article has shown that it is possible to couple the computing power of relatively cheap modern computers and CAD packages to new or existing mechanical equipment to produce a CNC system for the model engineer. Such an arrangement adds a new dimension to our activities.

The addition of a computer and stepper motors in your workshop allows a number of facilities previously not available to the amateur. It could, for example, allow a number of identical items to be produced having first designed them on the CAD package. Some of these items could be very complicated and difficult to make using conventional methods. I am going to use my table as a pen plotter to check designs, fitted with a scribe to mark out parts, or with a diamond tipped stylus to engrave on glass. You can also scale items by changing the lead screw you enter into XYTABLE. If you enter a value twice the actual pitch the result will be a half size item; enter half the pitch and the item will be twice full size. The number of applications is, as they say, only limited by the imagination.

Postscript

For a copy of the software mentioned in the article, send an order to: B. Pinchin, 10 Epping Drive, Melton Mowbray, Leics., LE13 1UH, enclosing a cheque for £17.50, payable to B. Pinchin.

For a full size positive of the Printed Circuit, which will enable a PCB to be made by the reader, or purchased from a local supplier, send to M.E.W. (X-Y Table), Nexus Special Interests Ltd, Nexus House, Boundary Way, Hemel

Hempstead, HP2 7ST, including four first class stamps. (Overseas readers should include a cheque for £2.50, payable to Nexus Special Interests Ltd.).



Table 8 X-Y Table component Suppliers

Oilite bushes, Toothed belts and pulleys

Hinchcliffe Precision Components
Avenue Six
Stonford Lane Trading Estate
Chesterfield
Derbyshire S41 0QZ

Lead screw and nuts

Engineering & Scientific Equipment Ltd
22-26 Mount Pleasant
Alperton
Wembley
Middlesex
HA0 1TU

Stepper Motors, Ball Bushings, Precision ground shafts, Electronic Components

Electromail
PO Box 33
Corby
Northants
NN17 9EL

Electronic Components

Maplin Electronics
PO Box 777
Rayleigh
Essex
SSW6 8LU

Farnell Electronics
Canal Road
Leeds
West Yorkshire
LS12 2TU

A BORING HEAD

This boring head will cover a large range of diameters, from quite small up to 200mm, or even more with a suitable cutting tool. The article has been provided for us by C M MacEke

For some time I had been looking for an improvement on my small Lushington boring head. Theoretically it is quite good; The No. 2MT shank fits the tailstock and has 0.02mm increments. The problem is that the cutting tool is held in place by two small grub screws which only have a couple of turns to grip. Overdo it, and the thread is stripped so the tool is never tight enough. The most annoying factor is that it will bore a hole reasonably well to almost $\frac{1}{4}$ in., then it has to be wound back and the tool inserted the other way round, whereupon it bores down to almost $\frac{1}{4}$ inch. The band left means another cutter has to be used. The tool flexes too easily and thus the incremental factor is lost. Having said that, I have used it for years.

A friend was selling up part of his workshop when I spotted this boring head. Unfortunately, or fortunately, depending on your view, he would not sell it. "It's been one of my most useful tools and I've had it over forty years" he said, and told me that it had been in constant use in his early days as an engineer. Such a simple device really, and capable of boring a hole from $\frac{1}{16}$ in. to 16 in. diameter, depending on the tool inserted, but no incremental adjustment. Although he wouldn't sell it, he was most helpful being willing to lend it

to me to strip down and make my own copy. He also gave me a blank body as he had begun to make another for some reason.

The original had a No. 3MT shank and was quite hefty but needed a draw bar when fitted in a milling machine. Unfortunately my milling machine has an R8 taper and there wasn't enough meat on the blank to turn this taper. Rather than start again, I stayed with No. 3MT and used an adaptor sleeve. This is fitted with a drawbar but it has a solid end so a new bar wouldn't pass through to the No. 3MT. I've fitted a removable tang to cater for both worlds. This can be seen in **photo 1**.

The boring head is best suited for the milling machine but I also need it for the lathe, so decided to make a second smaller

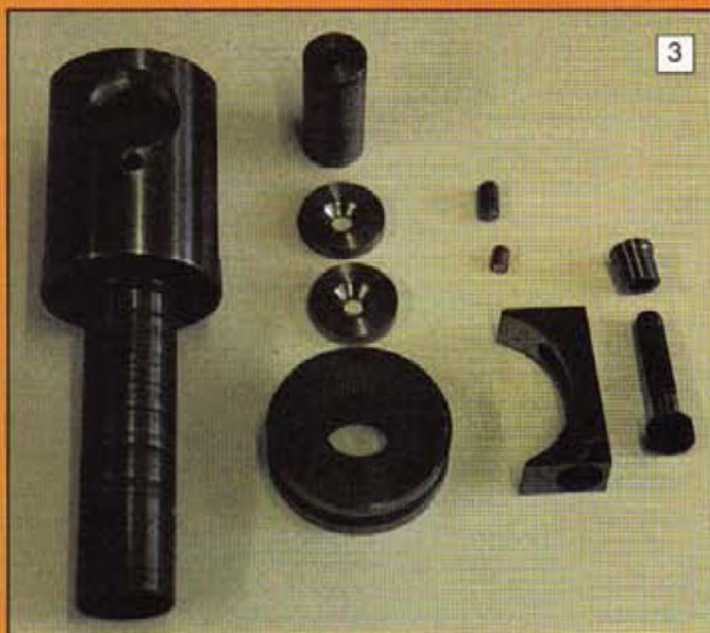
version with a No. 2MT shank to fit the tailstock. The two sizes are shown in **photo 2**. On the smaller one I didn't bother with a removable tang as I can't fit a draw bar anyway. Also, my headstock will take the No. 3MT version.

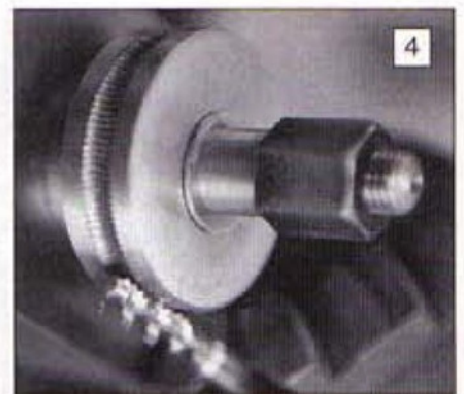
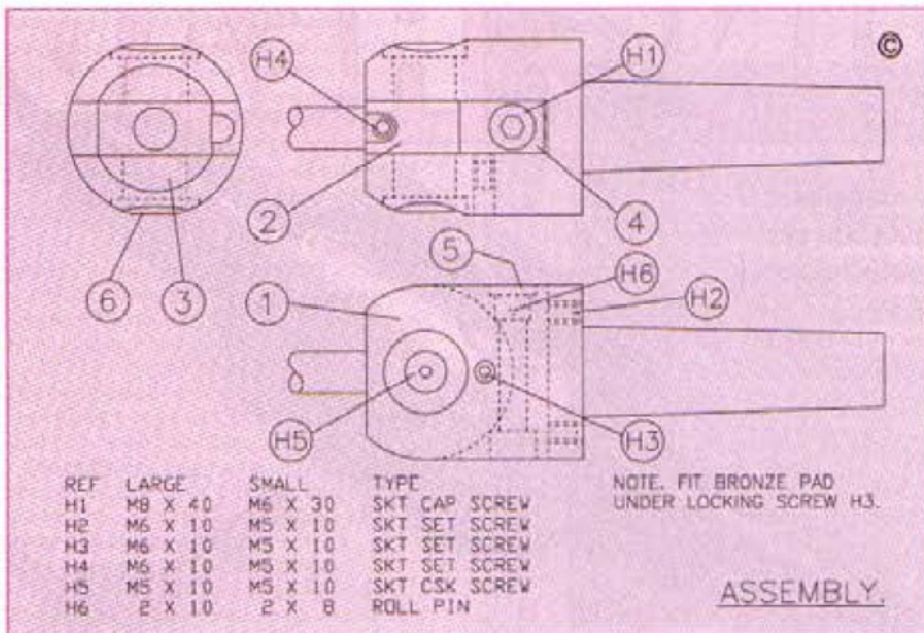
Construction is really quite simple as there are only seven pieces to make, seen in **photo 3**, not counting the tang. However, some degree of care is needed in places to avoid a sloppy fit. I made both tools and a box in a fortnight's spare time. I had never tried 'hobbing' before but had read an article some time ago and remembered the method. The main requirement is the helically fluted tap. One which I borrowed, was M8 with 1.25mm pitch but $\frac{1}{16}$ in. BSW would be fine. The

1: The tang can be made removable as shown if this permits the boring head to be used in alternative machines.

2: Two sizes were made, the larger with a No.3 MT and the smaller, No.2 Morse Taper.

3: All the major parts are displayed in this photograph, only a few additional screws being required.





4: Hobbing the tool carrier proves to be a very interesting operation.

Construction

Any reference to size in the text refers to the larger unit, but manufacture is essentially the same for either size.

Body (1)

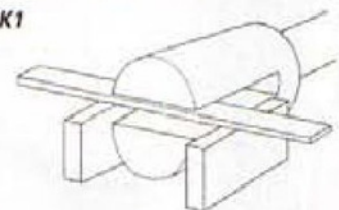
Start with a length of 50mm diameter steel, grip in the chuck and support the end with a centre. Turn down, parallel at this stage, over a length, and diameter, to suit the taper to be turned later. Reverse in the chuck and part off, or saw, the end to a length of a little over 62mm.

Now comes a part where some care is needed. The 15mm slot needs to be as accurate as you can make it from the point of view of having parallel sides. A variation on the width can be compensated for at a later stage. Try to be parallel to within a thou. or two. It's no problem if you have a milling machine, if not, drilling the base and sawing down, then truing with a file may be your only method.

A hole needs to be drilled through for the Pivot pin. This needs to be carefully marked out and at perfect right angles to the slot. I used my milling machine for this but a drill press would be usable. Place a bar of flat steel through the slot and rest on top of the vice jaws as in **Sketch 1**. I am assuming the jaws are at right angles to the drill bit. My largest drill was a 16mm which I worked up to in stages. Not having a 18mm reamer I went the rest of the way with end mills. The 4 toothed variety gives very good results. I counter bored with another end mill.

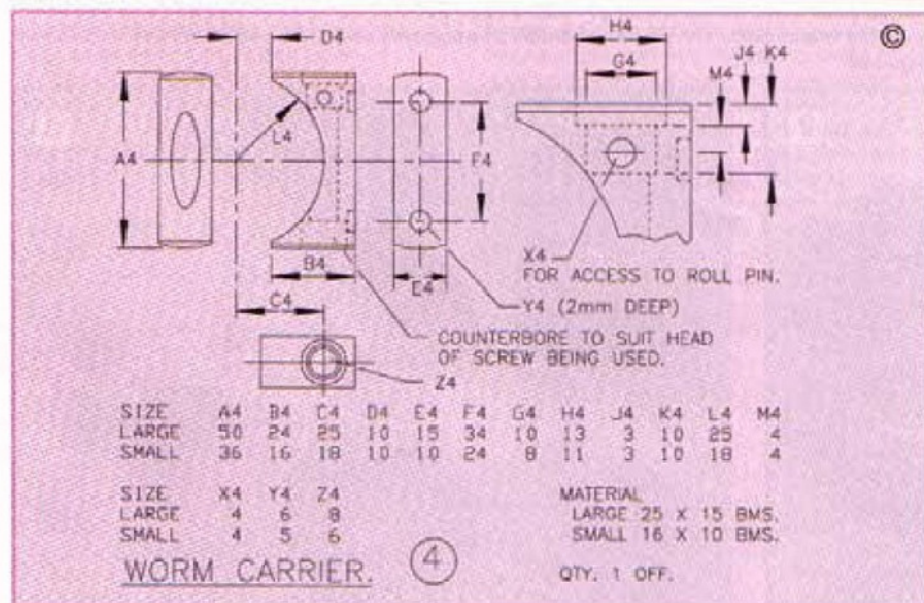
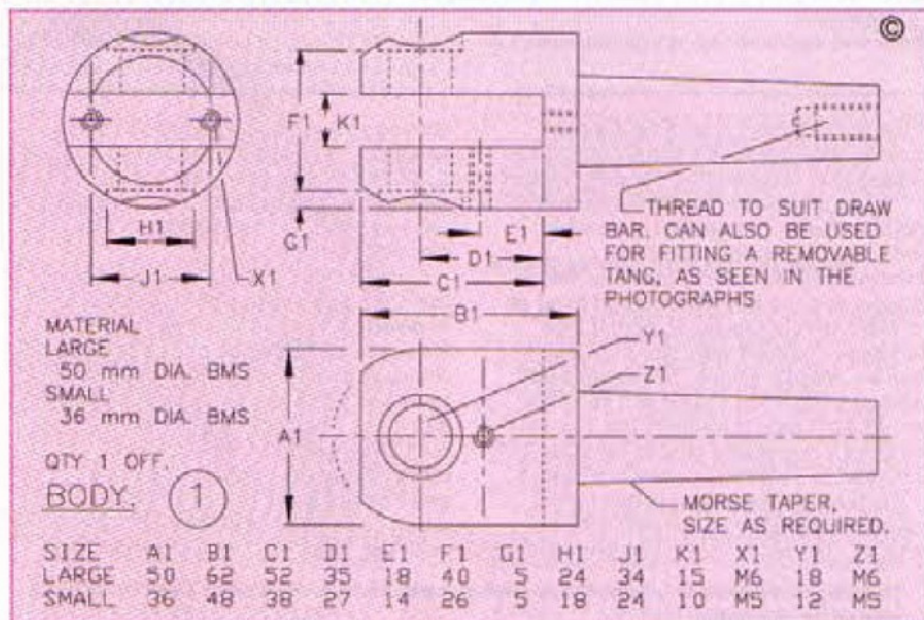
The M6 deepening screws may present a slight problem. I had to make holders to lengthen my drill and tap.

SK1



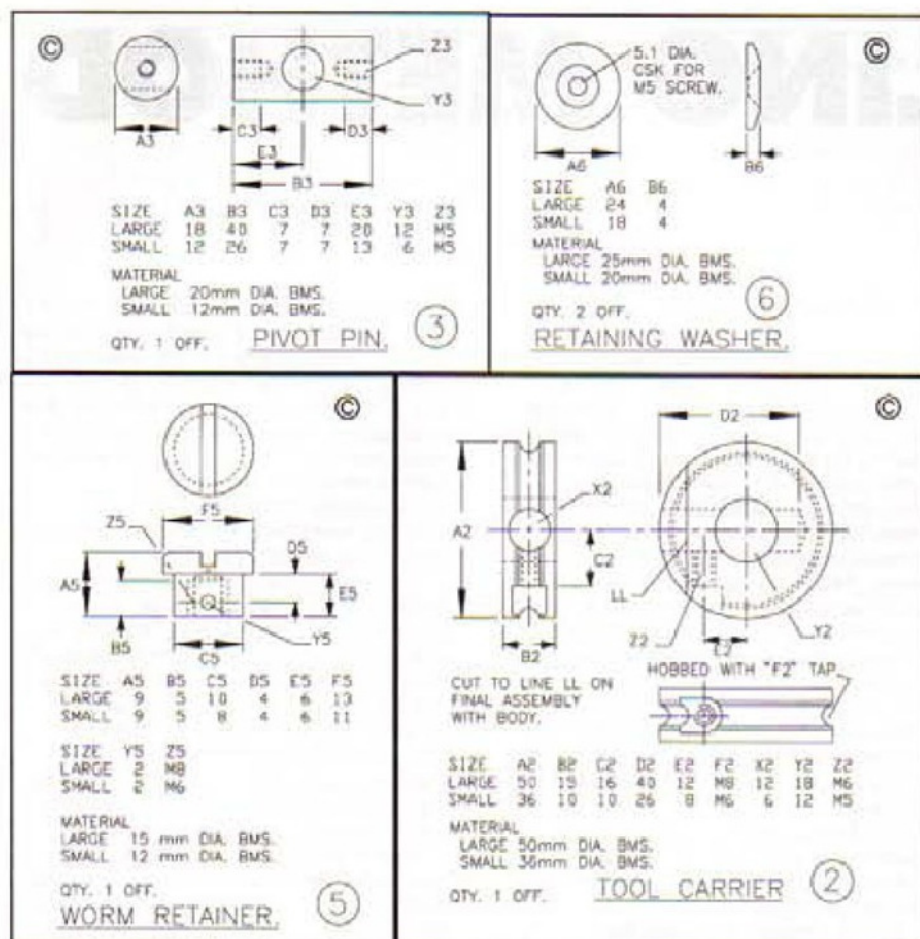
Tool carrier (2)

A piece of the same 50mm diameter steel is suitable but make sure that the hole bored is concentric to the OD by skimming the outer diameter. The reduction in size is not important. If a leaded steel like EN1A is chosen, it makes the hobbing easier. Use the same 18mm end milling machine to bore the centre hole. Grind a form tool to



second one, an M6 cost me 40p at a local car boot sale. If you've never tried 'hobbing', it's fascinating to watch. My first problem was that I couldn't strip

the original. Forty years on, and everything was solid. I didn't want to risk stripping the centres of the cap heads so I measured up and guessed what went on inside.



Worm retainer (5)

This is a straightforward turning job from a piece of 15mm diameter material.

Worm carrier (4) Making this part, which holds the cap screw, which drives the wheel is another problem area. Take a block of steel, 25 x 15 x 24mm and drill the clearance hole for the caphead screw, counter bore the ends. One to fit the cap head and the other to fit the worm retainer. Assemble as in **photo 5** and measure the amount of screw protruding. This has to be cut from the end of the caphead. The worm retainer has to be fixed to the caphead; I used a 2mm roll pin, you might prefer one of the proprietary adhesives. The whole thing needs to be rotatable without any end play.

Place the wheel on top of the block and scribe round it. This half moon has to be removed plus a bit more so that the wheel can engage with the thread of the caphead. A rotary table and milling machine is one way, or the face plate and turned on the lathe, another. The block will have sideways play, so to stop this the two depthing screws (H2) are recessed into the block. To locate them accurately, assemble the whole thing and tighten the depthing screws down hard. Disassemble and they should have left two witness marks which can now be centre punched and drilled to the required depth. The ends of the block are rounded to match the body so that no sharp edges appear on the finished tool.

If your lathe spindle will accept the Morse taper intended to be made, then now is the time to make this. If not, then assemble the whole unit and do up the locking screw (H3), hold in the chuck by the reduced diameter portion; centre drill, drill and finally ream 12mm through the tool carrier and pivot pin. The original assembly was almost ball ended, but this is not necessary, finish generally as shown in the drawing. Drill and tap for the tool locking screw. If it has not already been done, now is the time to cut the taper to suit the machine to which it is to be fitted. Be very careful not to spoil it; it is the last part of the job.

When it's all assembled, tighten up the depthing screws (H2) so that the action is as smooth as it will go without any play. The actual hobbing required is only a very small part of the whole, but the beauty is, it is no arduous task to make a new wheel should the old one get damaged. Finally, I took a small block of steel and fitted the 4 hex keys needed to operate the two boring heads. I find it a very useful little tool.



the approximate diameter of the tapping drill size for the helical tap. With this, a groove is cut on the circumference, make sure this is the correct distance (7.5mm) from the outer face. It is not critical but about 1/3 of the diameter is sufficient depth of cut. The tap will take care of any minor discrepancy. Part off a little over length to allow for facing to width. Make a tight fitting stub mandrel for the central hole, fit the tool carrier in reverse, and face off to fit the width of the slot already made in the body. This method will ensure the two faces are parallel, and it will be easy to ensure a close fit between the two parts. For this to be possible, the mandrel must project from the chuck sufficiently to allow the two parts to be test fitted whilst the carrier is still on the mandrel, and in the chuck.

Remove the tool holder from the lathe cross slide, and with an adaptor bush for the centre hole, place the carrier on the tool holder bolt, using spacer washers so that the centre of the groove is exactly at lathe centre height. The carrier needs to rotate freely but without any vertical or side play.

Photo 4 shows the arrangement well. Make sure that the chuck grips the tap tightly, as the side load will tend to work it loose. Some taps have a centre hole at the bottom of the thread, if so, the tailstock centre can be used to give valuable extra support. It is better not to use a tapping compound, this impedes the fall out of swarf. Normal cutting fluid could be used if necessary. Set the lathe to a slow speed and bring the wheel up to the centre of the threaded portion of the tap. Don't feed too hard or the tap will bend and may break; not too lightly or the cutter could skip parts and then there wouldn't be a fit. Don't worry about PCD's, it just seems to work. I tried several test pieces of random

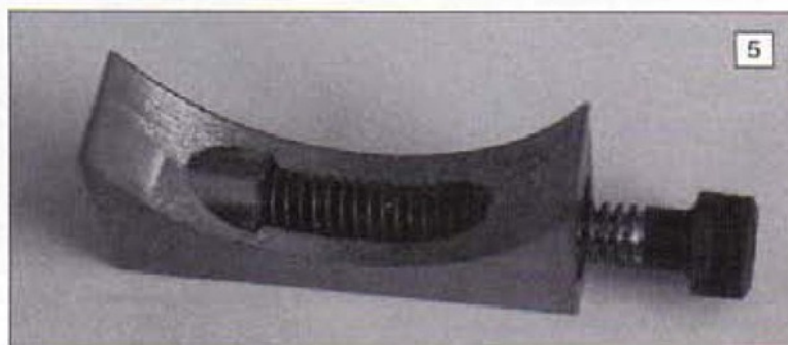
diameters and they all worked perfectly. As the wheel completes each turn, gradually increase depth of cut until you are happy with the finished result. Leave the carrier at this stage for more work later.

Pivot pin (3)

Make this from a piece of 20mm bar, reducing to 18mm, that is a close fit in parts 1 and 2 already made. It needs to be slightly longer than its socket in the body, say plus 0.1mm. This is so that the retaining washers can be done up tight and allow the axle to rotate. You can always use a shim washer if it is too tight.

Retaining washers (6)

These need no explanation, other than to say that the slight dome effect helps them to blend in with the shape of the body. This need only be an approximation and only a little care is needed in this operation.



5: The worm carrier. The worm (cap screw) has still to be reduced to the required length.

A DRILLING METHOD FROM THE PAST

Bob Loader proposes a method for adding a little more accuracy to your drilling.

In 1959 or 60, I can't remember exactly when, I was working at a Ministry of Defence Research establishment on a ground radar installation, where a small group of engineers, designers, draughtsmen, and, at the bottom of the heap, four or five of us who were called, 'Research and Development Craftsmen (special)'. We treasured the 'special' because it meant a bit more money.

The job was held up for a component which, because of its tolerances and other factors, had to be jig-bored. There was a long wait for jig-boring, so I suggested to the charge hand that it could be done by other methods. What I had in mind was the toolmakers' dodge of 'boxing' the holes by enclosing the hole positions in an accurately marked box. All that is needed for this is a vernier height gauge, an eye glass or scale reader, a hammer, centre punch and a drilling machine. I almost forgot the last thing needed, a bit of patience.

It appealed to the charge hand, because there was a bit of friction between us and the rest of the organisation, mostly because we were detached from the main workshops and not answerable to the system in the normal way. It was the first time I'd used the method in anger, and I wondered if I'd been a fool to offer and if I'd opened my mouth before the necessary thought had cleared the brain. It is a good way of drilling holes in accurate positions, with very limited equipment.

A practical example

More about ancient history later, I had a job to do recently which was ideal for finding out if I could still use boxing with any accuracy. It was a small vice I was making for the Unimat, and it needed four holes to clamp it to the cross slide, it wouldn't have mattered all that much if the holes had been accurate to rule measurements, but nicer if they were a bit better. The vice was of unit construction, I could just work on the base. **Fig.1** shows the section worked on and **fig.2** the marking out. I left out the fourth hole and concentrated on the three in line.

A vernier height gauge or an equally accurate instrument is essential for the marking out. I know that it is an expensive item but I got round it by making a conversion for my vernier calliper. It isn't that difficult to make, the photograph of the marking out shows what it looks like. (*The vice was featured in issue 26, the vernier conversion in issue 25 - Ed.*)

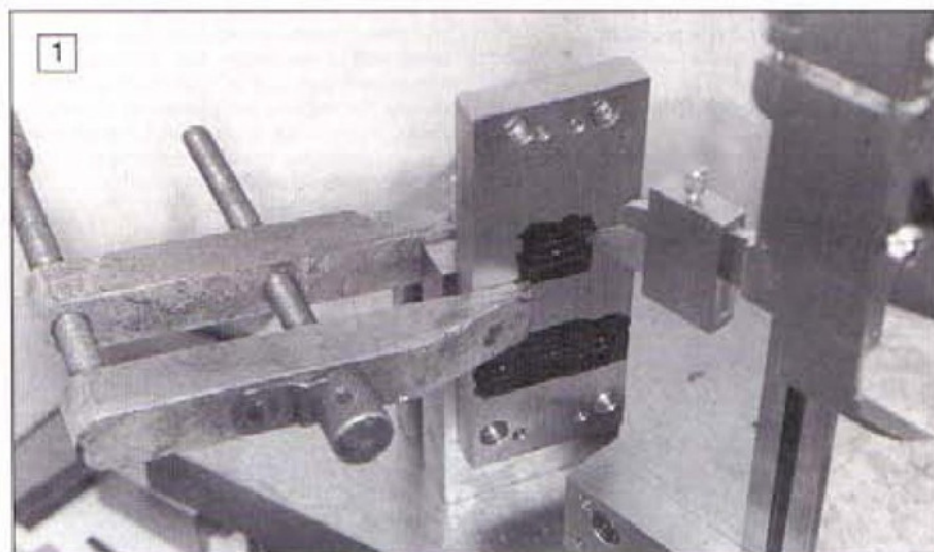
Once the holes have been marked out and boxed, they are centre punched as accurately as possible. Use the eye glass for checking and even then you'll be surprised how errors will show up as the job proceeds. As a base for the marking I used one of those broad permanent marker pens. Make sure that it is spirit based - the water based type are useless for this job. For interest I use a black Papermate M.15.

Photograph 1 shows the process underway. For the drilling, start off with a drill a bit under the finished size. $\frac{3}{16}$ in. or $\frac{1}{2}$ in. will be suitable. Let the drill find its own way into the centre punch mark by holding the job lightly but firmly and letting it move a little if it wants to. Take the drill in until it is

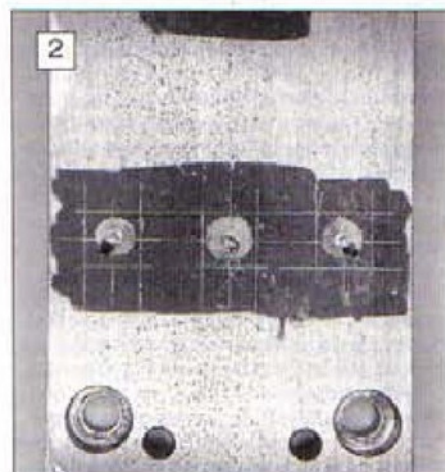
getting close to the box lines. Don't let it cut its full diameter: if you do you won't be able to correct it. **Fig.3** shows the nuts and bolts of the process. **A** is the desired effect, the hole sitting nicely in its box. **B** is what usually happens and the correction which needs to be made; **C** is the result of the correction, or in exceptional circumstances the result of complete accuracy in marking out, centre punching and drilling with the pilot drill.

For those doing the job for the first time, it is as well to have a go first on a piece of scrap material, to get used to the way the drill will move when its centre is punched over. It is not easy to give an idea of how much to punch for a given error and sometimes it will need more than one correction. This is why the pilot drill should be stopped as soon as it shows its witness mark. Once any drill is cutting its full diameter it is very hard to shift.

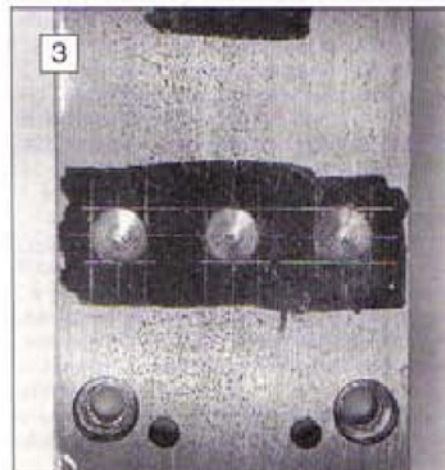
Some descriptions of boxing recommend using a chisel for moving the drill centre over; I can never find one small enough or with the right shape and much prefer to use a centre punch. **Photograph 2** shows the holes with their correcting done: the central one is the easiest, needing to move one way only, the other two having to move diagonally.



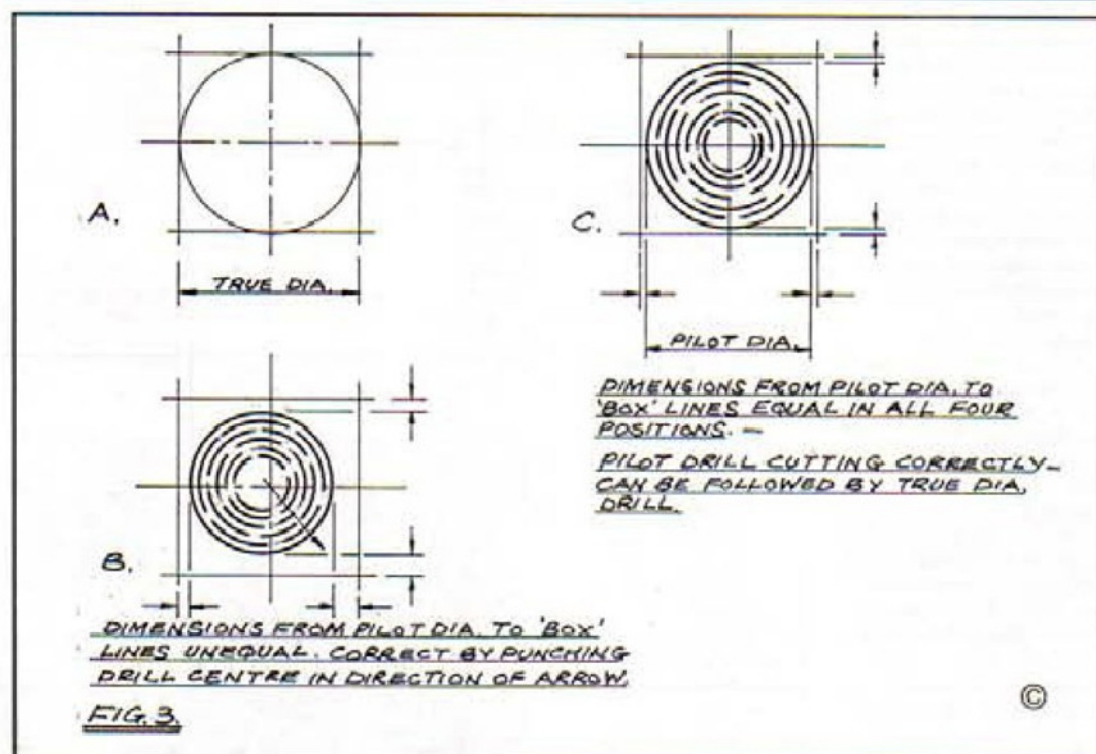
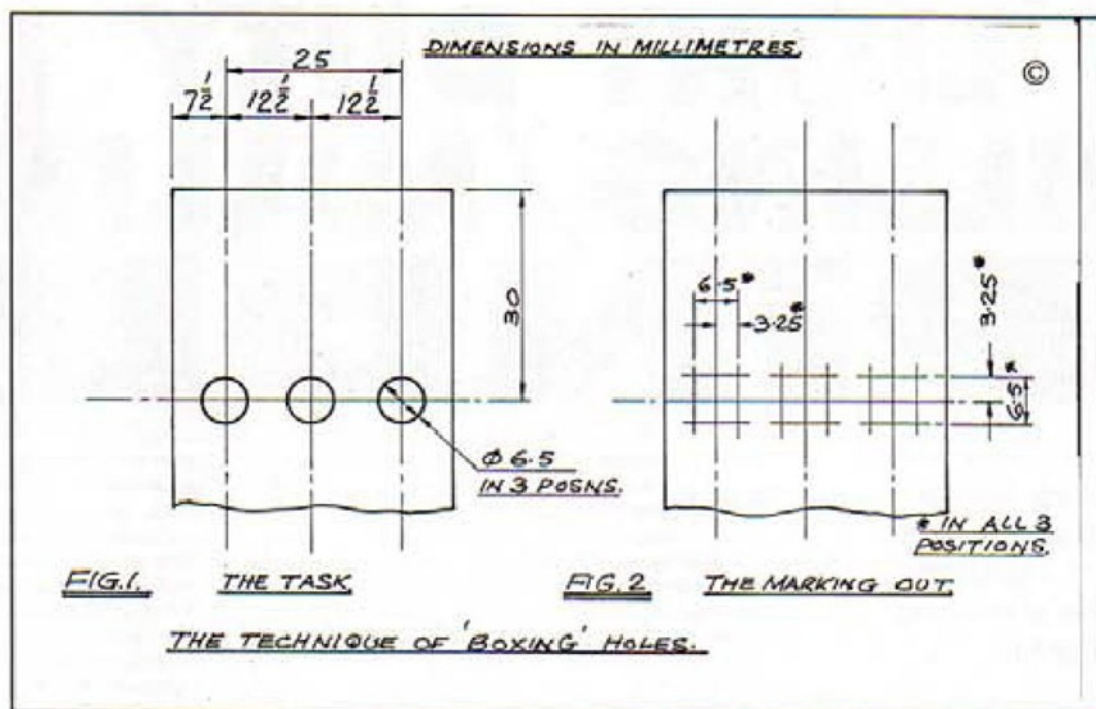
1: Marking out the vertical box lines. The vernier height gauge shown is the home-made conversion previously described.



2: The first stage in the correction. Centre punch has been used to move the centres of the holes. Note how easy it is to see the errors by the fit of the holes in the box.



3: All ready for drilling with corrections done.



LIGHT DUTY DRILLING/MILLING SPINDLE

Geoff Gray provides us with a design for a simple light duty drilling/milling spindle. Even though simple, he illustrates that it is capable of carrying out a range of tasks.

The first drilling spindle I made was not as versatile as I thought it would be. I recently made a new one with the bearings much further apart and able to fit on the topslide at centre height on a suitable packing with the pulleys clear as seen in **photo 1**. The finished spindle can be seen in **photo 2**, together with the closing nut, a collet and a blank collet.

As far as I am concerned tools are only a means to an end and when making a particular tool I have to keep on thinking of the alleged benefits it will bring me in order to really enjoy making it.

I made the spindle with a ballrace, 22mm OD x 7mm wide x 8mm bore, at the nose end and a plain bearing at the tail end. It could have been made with two ballraces or two plain bearings. With plain bearings it is easier to make but needs occasional lubrication.

A 6mm dia. shaft may be considered a bit on the light side. This could be increased using a larger bore ballrace.

The nose is screwcut and bored to suit the Peatol closing nut and collets. I bought a spare nut and six blank collets which can be bored out to a maximum of 8mm bore. I have had my Peatol lathe for ten years now and it and the collets are still giving first class service.

Make a start by setting the 16mm (5/8in.) square bar central in the four jaw chuck, setting by the faces and not the corners. Some BMS is a bit short on square corners. Drill and ream 8mm dia. about 10mm deep. Next turn a 8mm dia. spigot about 8mm long on the end of a piece of 30mm dia. BMS. Press this into the square bar and silver-solder together.

Reset in the four jaw chuck and drill about halfway through to the drawing sizes. Then bore out for the ballrace. The ballrace can be a press fit, or as I prefer, a sliding fit using one of the modern retainers to secure. Now reverse the bar in the chuck and drill through and bore out for the plain bearing.

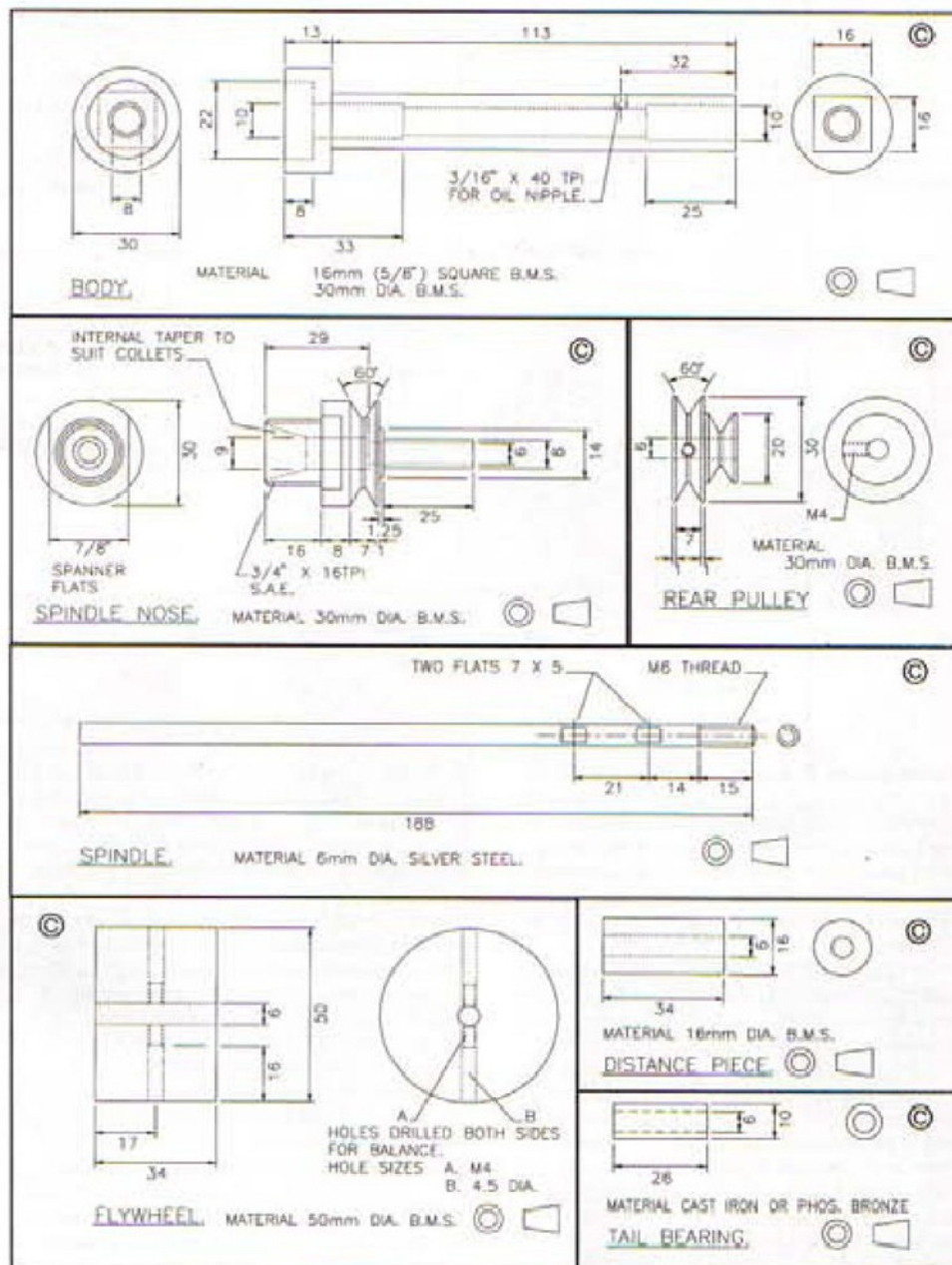
I made the shaft itself in two parts mainly to cut down the amount of work. The only real stress the bonded joint is subjected to is torsional stress when being driven from the tail end pulley and the 25mm long joint is well able to cope with this.

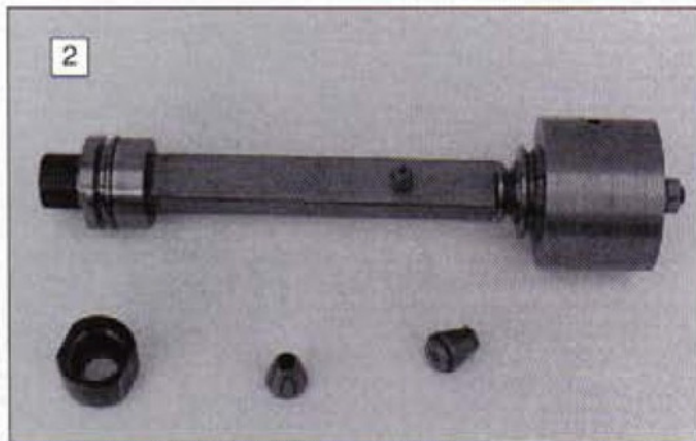
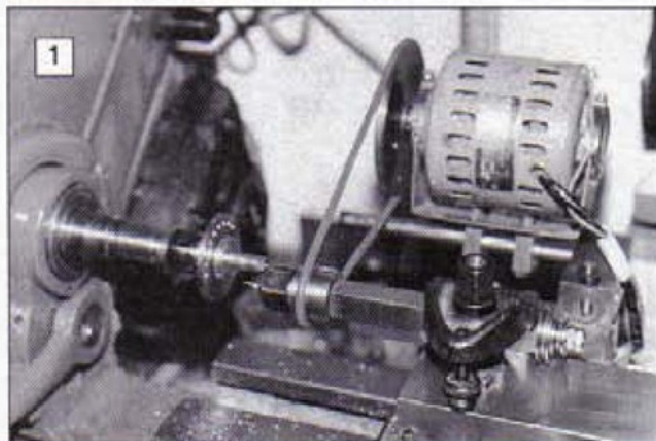
Now chuck a piece of 30mm BMS, in the three jaw chuck and turn and screwcut the thread using the closing nut as a gauge. Next drill through 5.5mm dia. true up with a small boring tool to 5.8mm dia. and as deep as your boring tool will permit, then drill through at 5.8mm dia. and then 6mm diameter. Finally at this setting bore the taper for the collet using a blank as a gauge. Remove from the chuck and saw to length. Part it off if you prefer, I find it less stressful to let my power saw do it while do

something else of more use.

Put a piece of 10mm dia. BMS in the three jaw chuck, centre drill the end and support with the tail stock centre. Turn a 50mm length to 6mm dia. a push fit for the nose piece and secure with a spot of retainer.

Now turn the spindle nose for the ballrace, still supporting the mandrel with the tailstock centre. Make it a sliding fit and again use a drop of retainer to secure the race. Remove from the chuck and release from the mandrel by applying some heat.





1: The spindle in use, here drilling holes on a PCD in preparation for making a twenty tooth chain wheel sprocket.
2: The spindle with collets and closing nut.

Reverse and return to the chuck. Now open up the 6mm dia. bore to 9mm dia. to a depth of 29mm as shown on the drawing.

Complete the part by making the Vee groove for the drive belt.

The remaining parts were straightforward to make and no explanation is required, other than to say, make the tail bearing a sliding fit in the body and fit with a retainer.

I have found that fitting a small flywheel to the spindle gives a better surface finish when using multi tooth and flycutters. Some of the photos show the spindle before I altered it to take the flywheel. Since it is not needed when drilling and will not fit over the topslide, I replace it with a distance piece for these operations. (I think I would leave the distance piece in place and bore the flywheel to fit over the this. This would avoid having to re-adjust the spindle end nuts for each change of use - Ed.).

Before fitting the plain bearing file an oil groove about 1mm deep starting at the inner end and finishing about 6mm from

the outer end. A three square needle file is best here.

All parts that are to be chemically bonded should be cleaned with a degreasing agent. After assembling adjust the two locknuts to eliminate any end play before tightening the grub screws in the pulley and flywheel.

Photo 3 shows the spindle set-up for centre drilling 24 index holes around the rim of the three jaw chuck backplate and the driving motor mounting using the topslide clamping stud. This is a very flexible arrangement. (See the article on *Saddle stop and Index arm elsewhere in this issue - Ed.*)

In photo 1, a 20 tooth chainwheel sprocket is being centre drilled, prior to drilling through to for the bottom radius of the tooth space. In this set-up the motor is bolted to the rear of the cross slide, I have also made a No. 2 Morse taper arbor with the nose screwcut and bored, again for Peatol collets. It is used to hold the 8mm dia. mandrel holding the sprocket in this set-up, of course it requires two collet closing nuts. As this arbor can also be used for holding milling cutters it is also through drilled for a drawbar at the small end of the taper.

Photo 4 shows the set-up for cutting the sides of the sprocket teeth with a 1.5mm slitting saw and the spindle mounted on the vertical slide.

The top slide clamping stud is used

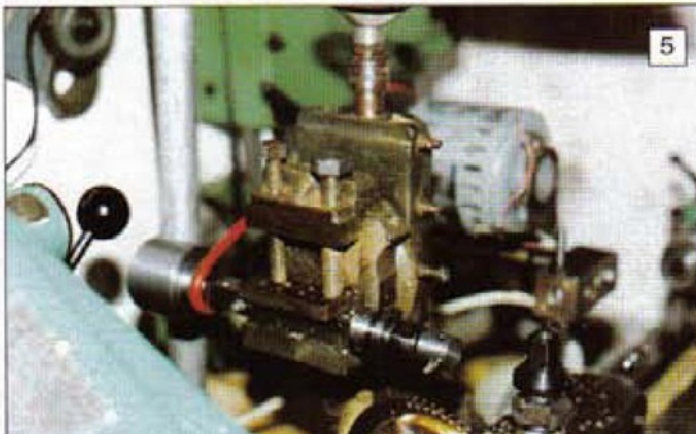
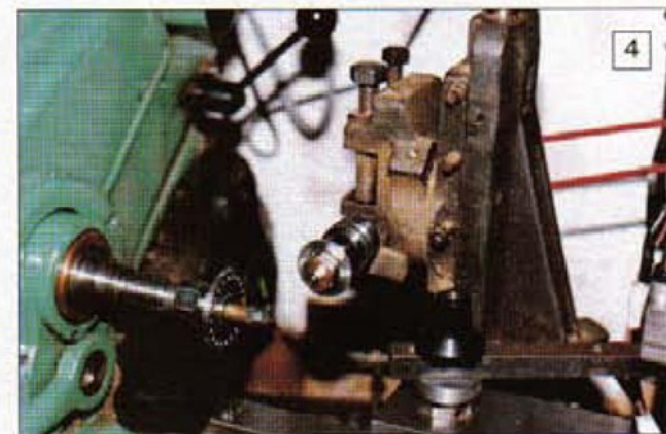
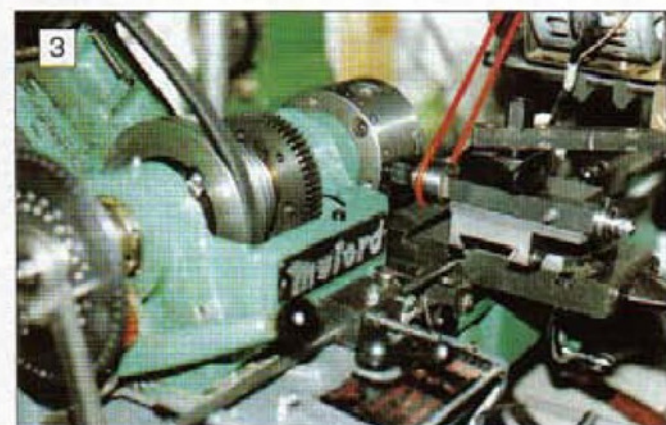
to hold the motor again. The vertical slide is off my previous lathe, a Halifax 524.

In **Photo 5** teeth are being cut with a flycutter in one pass on a 1.5mm x 100mm dia. brass disc, it is supported on each side by 5mm thick discs. Note the flywheel in use.

With regard to the safety aspect, it would be extremely difficult and time consuming to fit guards over the belt and cutter for every set-up. I think the average home workshop enthusiast has a responsible attitude towards safety. After all he owns the tools he is setting up and working with and his lathe could be at the top of his pride and joy list, he does not want it sullied with blood.

This is a different attitude to the man in a factory doing the same repetitive job every day, a job he became bored with a long time ago. He needs protecting from himself and his machinery.

So I will conclude by advising that eye protection is a must, particularly when flycutting brass.



Supplier details

Collets: Peatol Machine Tools, 19 Knightlowe Road, Harborne, Birmingham, B17 8PS. Tel. 021 429 1015.

Bearings: HPC Co. Storforth Lane Trading Estate, Chesterfield, Derby, S41 0QZ. Tel 0246 209683. Fax: 0246 205795.

3: Drilling holes in the backplate of a lathe chuck for dividing purposes.

4: With a slitting saw cutting out surplus metal to create teeth on the sprocket seen being drilled in photo 1

5: Flycutting teeth, in one pass, on a 100mm diameter brass disk

The subject of our reader visit in this issue, Simon Trendall, is another of our younger readers. The visit also highlights the very wide range of workshop activities in which readers of this magazine are involved.



4

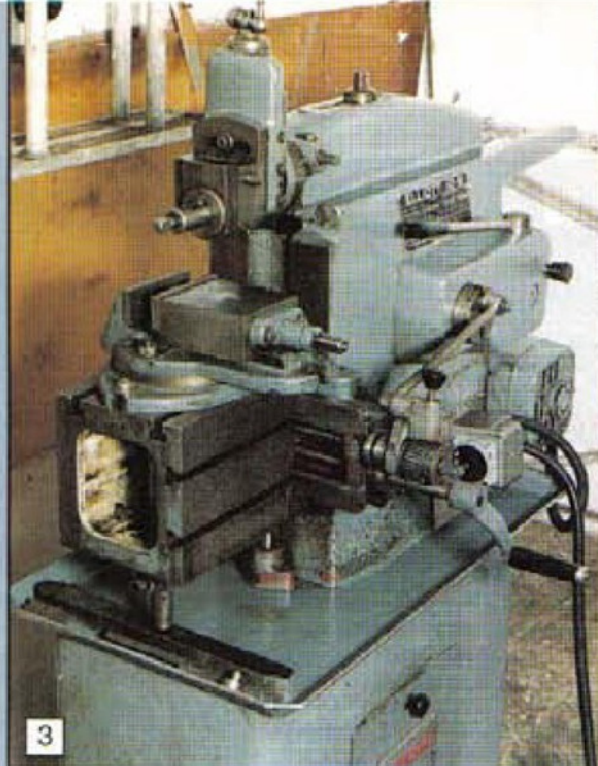
Simon, now 28 years old, acquired his interest in machine shop work from his father, and while only 10 years old. At around the age of 20 he commenced his own workshop, at the time being used mainly for motor vehicle maintenance and restoration. From this it has been an easy progression into his present interest, the field of military hardware restoration. During this time he has restored, an International Half Track (made in the USA) and a 40mm Bofors anti aircraft gun made by the Otis Elevator company of Canada. Also, seen in **Photo 1** before restoration, a Panhard AML armoured car with 90mm gun of French origin.

Simon has developed this interest into a full time occupation, which also includes locating and acquiring specific items for interested collectors. This can be complete items or just spares for the restoration of incomplete vehicles by others. Some readers may have reservations on the moral aspect of trading in arms,

as I do myself in the case of small arms, but Simon assures me that there is nothing to be concerned about. Apparently, military hardware released by the MOD for acquisition by private individuals is always disabled by drilling holes in the barrels. However, some reputable museums do like exhibits to be in working order for the sake of correctness. In the case of private

individuals, Simon will not provide items unless it is to a known reputable collector.

As an indication of the number of private collectors, the D Day Show, recently held at Southsea, had some 1400 vehicles on show, apparently, around 95% of these were privately owned. Simon has not the room himself for storing large restored items so these are disposed of to collectors,



3



1

We visit **SIMON TRENDALL**

In addition to his activities carried out as an individual, he is also involved in a number of associations with military vehicle interests. The main one is as a "Friend of the Tank Museum" at Bovington. There are apparently around 150 active "friends" though of course not all are involved in the activity of restoration. As an indication of the level of interest, some 17 "friends" went to the Munster Military Museum in Germany, for two weeks, to restore two Comet tanks. They took with them two engines, one a

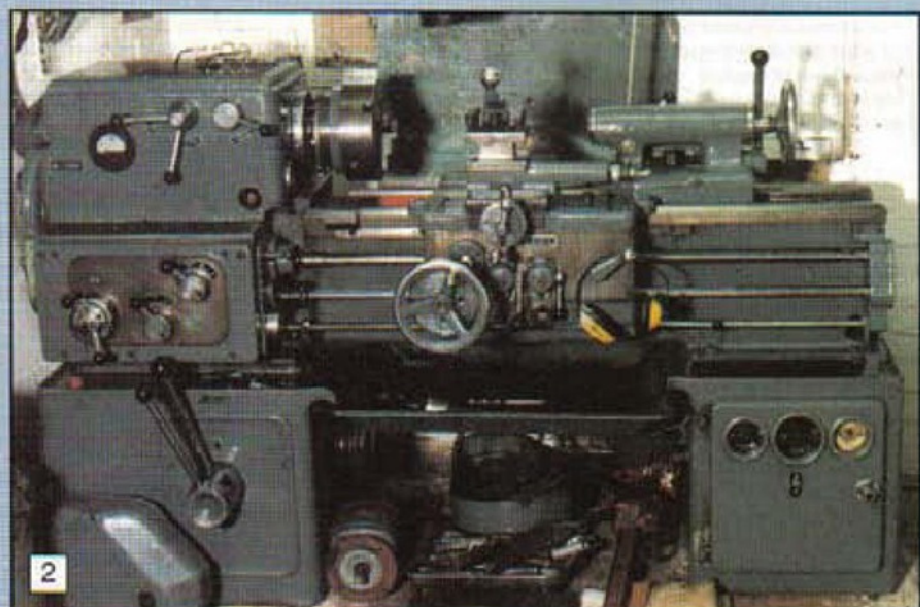
runner, and a second for a static tank for display at Dresden.

On entering his workshop, two impressions are immediately gained. Not surprisingly, the size of the machines, and secondly that the number of machines is limited to just two, a lathe and a shaping machine. Simon points out that he also has access to his fathers workshop. A quick visit to his fathers workshop, a wooden shed in the garden, while Simon's is in the garage, reveals a much more usual workshop, typically Series Seven lathe,

Taiwan mill/drill etc. His Father also has turned his hobby into a paying concern, making "brass masters" (patterns) for the production of castings for all types of miniature transport, including military. So Simon and his father are working at opposite ends of the size spectrum. His fathers workshop would make a fascinating reader visit. Some sheet metalwork is also involved, not your 16swg variety, more your 1/8in. / 1/4in. plate, I imagine. In this case most of the work is done by another. Also, Simon has no facilities at home for the storage of vehicles being restored, neither for the heavy lifting which is involved. The services of a local firm, provide the use of a yard together with the essential feature of a 6 ton gantry.

Back in the workshop we find a large lathe, 15in. swing 32in. between centres. This is a Russian made Stanko which was purchased secondhand, seen in **Photo 2**. Prior to that Simon had had a second hand Colchester Student and before that a new Harrison M250. The only other major item is the Elliot 10M shaper seen in **photo 3**.

Both machines are fitted with 3 phase motors and are fed from a single phase to three phase converter. This has been installed and has worked without any problem. The rating of the converter is sufficient to permit both machines to run at the same time, useful as the shaper can be left to run on its own while using the lathe. The size of the small (?) tools seen on the shelf in **Photo 4** indicate that Simon is not into the more usual activities of the home workshop, and we thank him for letting us into his rather specialised interest.



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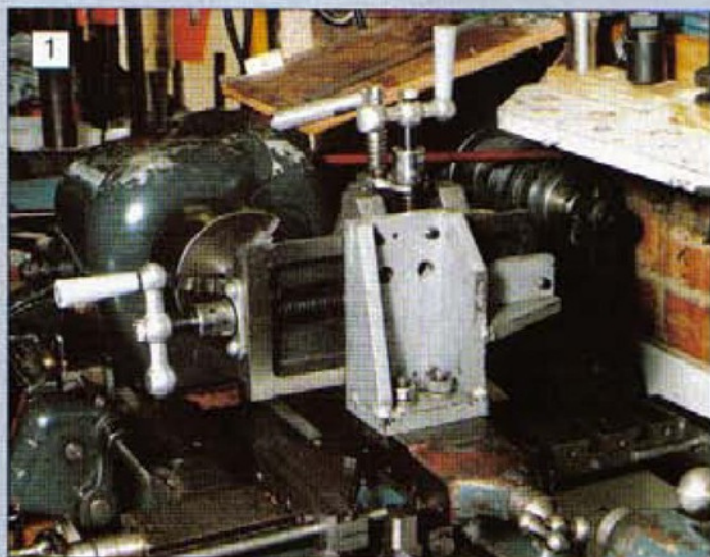
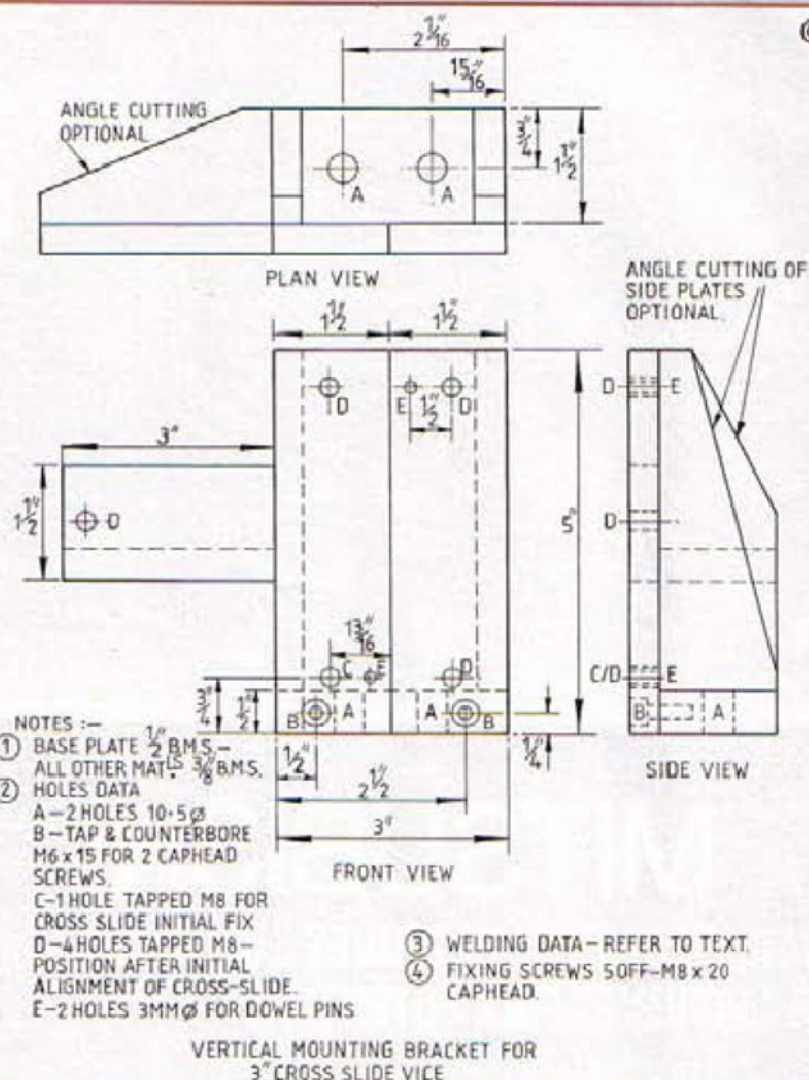
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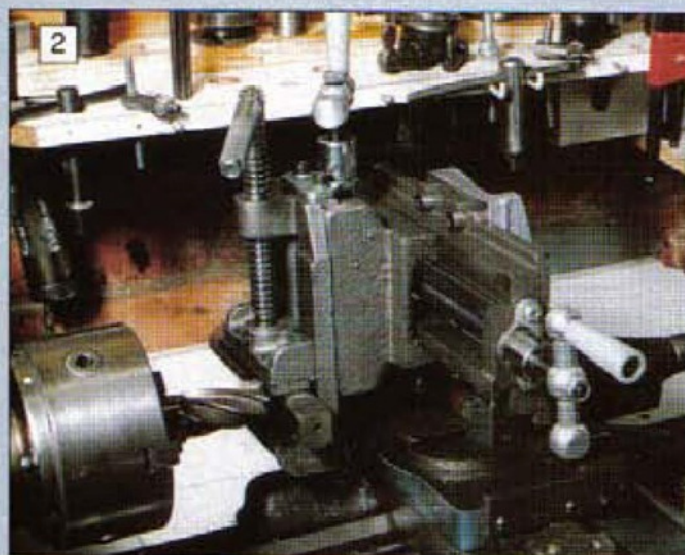
M. D. Pengelly describes how he converted an economy cross vice into a vertical slide for use on his lathe.

I had been making do without milling facilities in my workshop for far too long and decided to do something about it. With workshop space at a premium, and the likelihood of fairly infrequent use, I decided to see whether I could meet my requirements by making or buying various milling attachments for my lathe, a Smart and Brown. An article in the June/July 1991 issue of *M.E.W.*, by Ted McDuffie encouraged me along this path and I began looking for a suitable vertical slide. For various reasons, none of the commercially available units seemed to suit my purpose. While considering the implications of making one, I came across a compound cross slide vice that I had used some years before as part of a simple lathe. The unit was 4in. model which was too big, but I could see that a smaller model could be mounted vertically and adapted to suit my purpose.

Low cost cross slide vices are mainly Far Eastern imports and are available from many machine tool suppliers. They consist of two screw operated slides set at right angles to each other, with one of the slides having an integral machine vice. With the Model Engineer Exhibition at Alexandra Palace just a few weeks away at the time, I deferred purchasing the cross slide until I had been able to compare what the various suppliers there had to offer. Although there were one or two different products, most suppliers seemed to be offering the same thing, albeit painted in different colours. In the end I purchased a 3in. model from Graham Engineering for £22. On this



1: The slide shown mounted on the top slide



2: Being used to machine a square on the end of a bar.

model the jaws of the vice are 3 1/2 in. wide with a depth of 1 1/2 in. The moving jaw opens to 3 in. and a substantial guide rod beneath this jaw eliminates any tendency for jaw lift. This problem was highlighted in the April/May 1992 issue of *M.E.W.* in the article *Milling for Beginners Part 1*. Construction is mainly of cast iron, except for lead screws, gib strips and replaceable mild steel smooth jaws. The longitudinal travel of the vice is 3 1/2 in. and the traverse 4 1/2 inches.

The lead screws have their threads handed such that slides traverse in the direction expected relative to the direction that the handles are turned. This is a distinct improvement over my earlier model where slides disconcertingly travelled in the opposite direction to that expected. Lightweight ball handles are fitted, together with collars that are graduated in 25 Imperial divisions of 0.005 in. giving a movement of 0.125 in. per complete turn. The gib strips are adjustable, with the centre adjuster on both slides being a thumb screw so that the slides can be clamped by hand if required.

Mounting position

There are no Tee slots on the cross slide table of my Smart and Brown lathe, and I had no choice but to utilise the Tee slot on the top slide that usually holds the 4-way toolpost. (*I took the photographs some time after the article was written. It would appear that tee slots have now been added. — Ed.*) In this way the attachment is very easy to mount and demount, and the top-slide taper turning pivot still functions, doing away with the need to provide the unit with a swivelling base, see **photo 1**.

At this stage I could either have made a mounting that would retain both slides or have separated them, mounting just the vice slide for vertical operation. I was concerned that retaining both slides would create an overhang that was too great for mounting in the way that was being considered. However, I decided to keep both slides to start with as conversion to a single slide unit would be easy if problems arose. In use, with all slides carefully adjusted, no problems have arisen to date.

Adapting the cross slide vice unit

To make the unit suitable for vertical use one or two minor alterations are necessary. Firstly, the operating handle for the lead screw of the vice slide is at the opposite end to the handle that closes the moving vice jaw. These must both be at the same end so that they can be operated from the top when mounted vertically.

Make a start by dismantling the vice slide casting from the cross slide casting. To do this, remove the vice slide leadscrew by undoing the screws that hold the thrust plate to the casting and wind the leadscrew out. The vice slide casting will now slide apart from the cross slide casting. Watch out for the hardened ball between the gib strip and the middle adjusting screw, as this can easily drop out and get lost. Dismantle the vice by removing the sliding jaw guide rod. This is held in place by a single grub screw. Separate the sliding jaw from the vice screw by undoing the keep screw. You now have the basic vice slide

casting, to which the leadscrew and thrust plate are to be fitted at the opposite end to where they were originally. See **photo 2**.

Before this can be done, the end of the casting must be machined flat to remove the draft taper. I faced the casting in the lathe by mounting it on a mandrel 1/2 in. dia. by 9 in. long. This was centre drilled at one end for a revolving centre and fitted through the guide rod holes in the casting. There is sufficient length to grip one end of the mandrel in the lathe chuck and the other end supported by a revolving centre in the tailstock.

Use the guide rod locking screw to hold the casting to the mandrel, this is sufficient for taking light cuts. Before facing the end of the casting, turn down the mandrel at the point where it emerges from the hole in the casting to a diameter of about 12 mm. This will allow the facing tool to cut beyond the edge of the guide rod hole; although a complete cut across the face cannot be made by this method, it will suffice for this purpose. Once the end of the casting has been machined, transfer the hole positions for the thrust plate from the opposite end, and keeping everything square and parallel, drill and tap the two holes.

The ball handle attached to the vice slide leadscrew will also need attention, otherwise the ball at the end will just catch on the vice jaw clamping screw. Leave the handle attached to the leadscrew and mount in the lathe chuck for a light skim to be taken over the OD, which will correct the situation. Before reassembling the unit there is one more task. The vice slide leadscrew operates in a threaded lug which is at one end of the cross slide casting and is an integral part of it. This lug will be at the wrong end relative to the changed position of the vice slide operating handle and must be reversed for everything to work correctly. The situation is easily dealt with by removing the cross slide casting from the base casting, and turning it around, after first taking out the cross slide leadscrew. Again, watch out for the ball under the gib strip on this slide. Reassemble the rest of the unit thus completing the work on the cross slide itself. Next, a start can be made on the mounting bracket and double tee bolt.

Mounting bracket and double tee bolt

Material sizes are not too critical for these items so long as the end result is substantial enough to provide a rigid mounting. I chose to fabricate from standard sizes of BMS because the flat surfaces and square edges of this material reduce subsequent machining to a minimum. The bracket, seen in close-up in **photo 3**, is mainly constructed from 1 1/2 in. x 3/4 in. BMS, except for the base plate which is a piece of 1 1/2 x 1/2 inch material.

Serious problems of distortion did not arise because welding was kept to an absolute minimum. For those without welding facilities it should be possible to construct the bracket using cap head hexagon socket screws. All welding was carried out using standard 2 mm diameter arc welding rods. The only sections that are "veed" before welding are those that are subsequently dressed off flat as a functional requirement. The 3 plates that form the supporting webs need not be cut

at an angle as I have done, but I think that to do so improves the appearance. Leaving the angles uncut until after fabrication makes clamping the parts for welding and drilling far easier, but the cutting more difficult.

Double tee bolt

This is constructed first as it will be needed for alignment checks of the vice and bracket during fabrication. The tee bolt is fabricated from 2 pieces of 1 1/4 x 3/4 in. BMS with one reduced in width to 0.9 in. Both pieces are chamfered at each end for welding, then carefully clamped together after ensuring that the step each side is equal. After welding, the ends are dressed and the M10 holes, drilled, tapped and heavily countersunk on the underside. Cut 2 pieces of M10 studding to length, face and chamfer the ends and screw into the tapped holes. Run a nut down each piece to rest against the face of the tee section. This will hold the studs firmly for welding. With the underside uppermost, run a weld around each countersink and "puddle" it in towards the middle to fill each hole completely. Dress the welds flat and this part of the job is complete.

Mounting bracket

Cut all materials to length. Clamp the two pieces that make the front plate side by side onto something substantial, such as a heavy angle plate, and weld together on the top and bottom edges only. Do not weld on the front or back faces to minimise distortion and leave clamped until cool. Drill the two holes for the double tee bolt in the base plate and drill and tap the two holes in the front edge of this plate. Drill the two lower holes in the front plate and assemble to the base plate with cap head screws. This provides the initial fixing of these two parts prior to welding. After welding, the holes can be recessed so that the screw heads are flush with the surface. Tap the plates into alignment as you tighten the screws, then clamp the two webs into position. Stitch weld the webs to the front and base plates and these two items to each other. By welding short sections at a time and allowing each weld to cool before tackling the next one, distortion will be kept to a minimum. It is also beneficial to sequence the welding so that short runs are done on alternative and

QUICK TIP Hardness comparison

An easy way to distinguish silver steel from mild steel, is to use an automatic centre punch. Set the punch to strike a very light blow. The mark on the silver steel will not be as wide as the mark on the mild steel, when viewed with a magnifying glass.

Robert Green

opposing faces, as this will also minimise distortion.

Next, drill and tap one M8 hole in the front plate. This is for the initial fixing of the cross slide unit to the mounting bracket, so that alignment can be checked before drilling and tapping the other fixing holes. Doing it this way deals with the rather imprecise open ended slots in the fixing lugs which are not machined but are "as cast". Fix the cross slide unit to the bracket by the one screw, plus a clamp to hold the top lugs down.

Set the lathe top slide at 90 deg. to the lathe cross slide and mount the vice and slide assembly in the tool post mounting slot, using the double tee bolt. Position the unit so that the top edge of the jaws of the vice are against a flat surface, such as the faceplate, and tighten the tee bolts. At this stage you can either set the horizontal alignment of the cross slide, or the vertical alignment of the vertical slide. As both axes are fixed relative to each other, setting one will automatically set the other within the accuracy of the unit. I chose to set the horizontal alignment as this was easier for me to check with the equipment I had. To do this, mount an engineers parallel, or a substantial piece of square or rectangular BMS, in the vice. This should be long enough to protrude for several inches beyond the width of the jaws on both sides. Before finally tightening the vice, tap the bar down to ensure that it is sitting squarely on the machined face at the base of the jaws. Establish rough alignment by measuring up from the top face of the lathe bed to the underside of the bar. Slacken the clamp and fixing screw and tap into position as required. Fine adjustment is achieved by mounting a dial test indicator in the lathe chuck with the stylus resting on the top edge of the parallel. Traverse the vice cross slide backwards and forwards whilst carefully tapping into accurate alignment. If you do not have a DTI, good results can be obtained by mounting a short piece of round bar in the lathe chuck and manoeuvring the cross slide vice so that the bottom edge of the parallel bar almost touches the top of the round bar. Traverse the vice cross slide and equalise the gap between round bar and parallel with feeler gauges. When you are satisfied with the alignment, nip up the screw and tighten the clamp and remove cross slide unit and bracket from the lathe.

Mark the positions of the other three fixing holes through the lugs in the casting. The remaining piece of $1\frac{1}{2} \times \frac{3}{8}$ in. BMS provides additional support for the cross

slide unit and is welded to the side of the mounting bracket front plate. To do this, mark the position of the tapped hole for the fixing lug on the end of the casting, drill and tap accordingly. Fix the plate to the casting with a screw and it will be in the correct position for welding, which can be done after tacking the supporting web into position. Stitch weld these two plates to each other and to the main bracket and allow to cool. Separate the mounting bracket from the casting and drill and tap the other fixing holes.

Complete any welding that remains to be done and cut the angles to the supporting webs if required. At this stage I decided, that although the face of the mounting bracket looked to be square to the base, it would be worth machining the base relative to the face to make sure. This was done by mounting the front plate of the bracket face down on to the lathe top slide with the double tee bolt after first drilling two holes in the plate. The base was squared against the lathe faceplate as it was bolted into position.

Fly-cutting the base should have been easy, but I hit a snag. Welds on this face, although previously dressed-off, were tougher than the surrounding metal. Although the fly-cutter bit was HSS, it tended to skid over the weld metal, leaving it slightly proud. I concluded that a carbide tool would probably cut better, but I had nothing suitable. This was remedied by adapting a $\frac{1}{8}$ in. carbide tipped masonry drill bit. I removed the carbide tip and after filing a flat on the shank of the drill, silver soldered the tip to it. I then re-shaped the tip a little with a green grit wheel before cutting the shank to a length suitable for the flycutter.

Although the grade of carbide was probably wrong for general machining, it made a good job of re-machining the base and, as I was only removing a few thou, it cleaned up the welds perfectly. Re-assemble the vice and cross slide unit to the bracket, using all five fixing screws. Re-mount on the lathe top slide and check alignment as before, because small corrections can still be made. Finally tighten all screws and that is the job completed except for finishing off and painting.

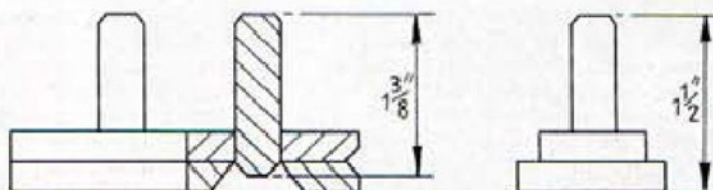
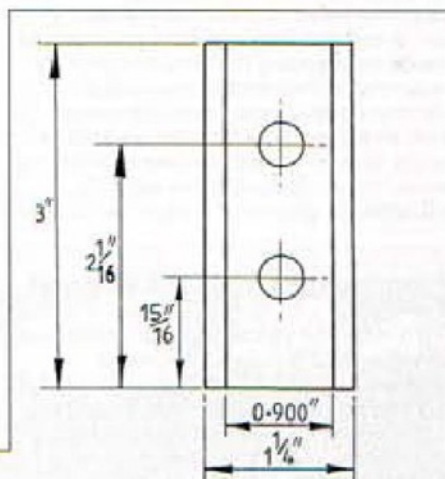
In addition to the five fixing screws I also dowelled the main casting to the mounting bracket using two 3mm dia. x 12mm spring dowel pins. These were positioned by drilling through the lugs adjacent to the top two and bottom two fixing screws. These ensure that everything is held in correct alignment without relying just on the

clamping effect of the screws. It will also ensure that the vice slide unit and the mounting bracket will re-register correctly if taken apart and re-assembled.

Working with the unit

For general use it will be quite adequate to mount the unit on the lathe top slide by squaring it to the lathe spindle with one parallel bar mounted in the vice and another against the chuck face. For greater accuracy check the setting with a DTI as described elsewhere in this article. I have found that the 3 jaw chuck is perfectly adequate for holding milling cutters and slot drills up to 25mm dia., it should be able to handle larger cutters, within the capacity of the lathe, and providing that the jaws are not worn. As with all machining operations, milling cutters must be very sharp otherwise the finish will be poor and undue pressure will be transmitted to the lathe and vice slides.

Wherever possible, I use the cross slide of the vice to position the work and the lathe cross slide under power to do the actual machining. Tighten or lock-off any slide that is not actually being operated, to keep everything as rigid as possible. I have found it particularly useful for milling keyways on shafts and for the cross drilling of round bar including cross drilling at an angle. Setting for these operations is simple and is an adaptation of a method described by a M.E.W. correspondent. The round bar, or a short piece of it, is first mounted in the 3-jaw chuck. Next, the vertical slide unit is positioned so that the fixed jaw just touches the underside of the bar. Lock the vertical slide in this position and when the shaft to be drilled or keyway is mounted in the vice it will be at the correct centre height.



HALF SECTION SHOWING WELDING PREPARATION.

MAT'L $\frac{1}{8}$ " THICK BMS M10 STEEL STUDDING.
WELDING DETAILS - REFER TO TEXT.

DOUBLE TEEBOLT

QUICK TIP Tap restoring

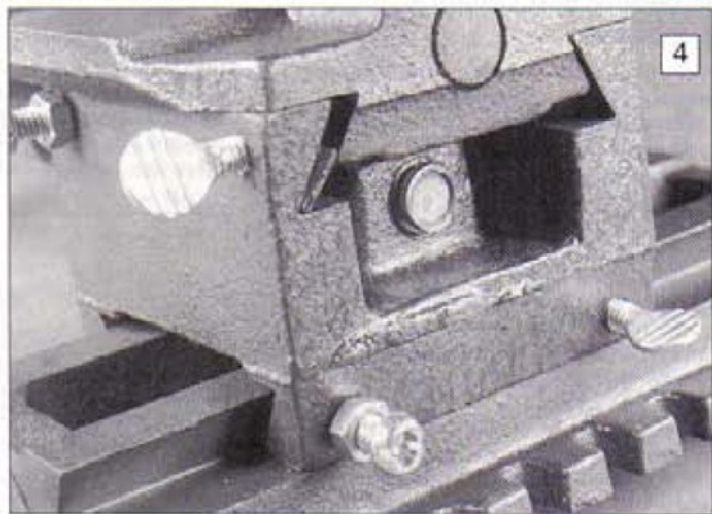
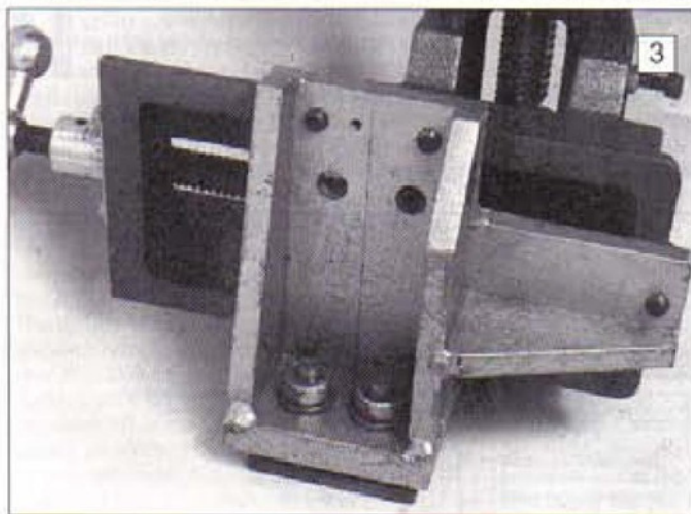
Taps which are showing signs of bluntness can easily be sharpened by stoning the cutting edges in the flutes. Usually only the first few threads have dulled and the restoration of a good cutting edge is simple if plenty oil is applied while stoning.

Alan Jeeves

Swivel the unit as required, for angled cross-drilling. For many machining applications you will find it easier to mount items in the slide vice rather than holding them in a 4-jaw chuck or clamped to the lathe faceplate as you would have done previously. With work held in the vice in this manner it is now possible to drill holes from the co-ordinates of their positions by using the vertical and horizontal slides and drilling from the headstock.

3: The mounting bracket in close-up.

4: Take care when choosing the slide to purchase. This photo shows a slide, supplied with a very poor gib strip construction to one of the slides. It did not come from the supplier quoted by Mr Pengelly in his article—Ed.



Conclusions

It would not be practical in this article to go in to great detail about the variety of machining operations that could be undertaken. Suffice to say that at a cost of under £30 and just a few hours work it is possible to produce an attachment for your lathe that will increase your machining capabilities considerably. Those not wishing to make the mounting bracket could achieve similar results by mounting the cross slide unit on an appropriately sized angle plate. Extra time could usefully be spent on making some refinements to the unit, such as new collars for the leadscrews with improved graduations and perhaps reducing backlash. However, I shall be using what little spare time I have to develop additional attachments for the

lathe to further increase its versatility. Finally, while I am confident that this project is adaptable to lathes other than the Smart and Brown, I would recommend that anyone wishing to build it for a different machine, should satisfy themselves that it would be suitable before buying the cross slide unit. A number of the suppliers advertising in M.E.W. stock them and a visit to one of them to check relevant dimensions would be worthwhile. (As it would to check quality. While even the poorest are quite good value for money, much better can be found. Photo 4 shows an example of a poor quality unit, purchased it must be said from a well known supplier. It also has one leadscrew that works conventionally while the other works in reverse—Ed.)

LINK UP

WANTED

- I am building a 1:96 scale model of a merchant ship on which the derrick posts are of hexagonal cross section. Can any reader, or advertiser, please advise me of a source of hexagonal brass tubing. 5/16in. across the flats, I require 6 x 6in. lengths. The origin of a length of this tubing I have seen may have been Germany or the USA so even any information in these directions would be much appreciated. J M Wood, 14 Hazlemere Avenue, Macclesfield, Cheshire SK11 8LZ. Tel: 0625 421452.
- Exploded view, drawing or sketch of a Centec 2A including the vertical head. Any expenses willingly reimbursed. Tel: 01628 477530.
- For the Herbert OV milling machine.
 1. A maintenance manual
 2. A collet (Herbert cat number 333) to take No. Morse taper shanks. Tel: 0476 61204.
 - For George Adams lathe, Size B, number 127, date 1914 centre height 4 in between centres 18 in.
 1. Handbook
 2. Any other information.
 3. Contact with any owner of a similar machine. Stainer, 225 Chickerell, Weymouth, Dorset DT4 0BS.
 - A users manual, or any other potentially useful info, for an Adcock and Shipley milling machine, model 1ESG, Walton, 24 Hargill Road, Howden-le-Wear, Crook, Co Durham, DL15 8HL.
 - Information, users handbook etc., regarding Herbert Junior hand operated surface grinder. Wooley, 150 Stamford Road, Manchester, M34 5WW. Tel: 061 338 5596.

- Operators Handbook and Spare Parts List for Harrison Vertical Milling machine (30 x 8in. Table) Circa 1975. Jones, Hart-Lea, Sutton Road, Wigginton, York, YO3 3RA. Tel: 0904 768365.
- Hardinge HLV narrow bed lathe. Serial no J 9224/1015. I have recently purchased this lathe knowing the gearing in the saddle is needing attention. Could anyone help in acquiring these gears 22 DP 14, 21, 45, 50, 66 teeth, bore size not important. Also a set of change wheels and manual, original or photocopy. Dave Dollimore, 1 Westglade, Farnborough, Hants, GU14 0JE. Tel: 0252 516725.
- Wanted to complete private collection, copies of Model Engineers' Workshop published prior to Dec 91/Jan 92 edition except summer 1990 and winter 1990/1991. Must be in mint condition: appropriate prices paid. A R Lynton, Hillside, Goatacre Road, Medstead, Alton, Hants, GU34 5PU. Tel: 0420 562226.
- I am restoring quite an elderly ML10. I have it running but I need some extras. Does anyone have a surplus vertical slide for sale and or a small machine vice (2/3in.) for use on the cross slide. Tel: 0937 573112.
- I have a small jar of "CROMIT" that I must have bought in the 1930's. When applied to a damp cloth and rubbed vigorously on to metal, it produced a "chrome" plate. I used it often on small parts, and the plating survived for many years. "Cromit" was made by the Munster Chemical Co. London, SW8 (label on the jar). Can anybody tell me of a modern equivalent. Pat Twist, Winchester. Tel: 0962 880475.
- I am interested in the subject of gearbox design, both for screw-cutting, which require exact ratios and for feed and speed control, which allow some variation from the ideal. Receipt of the Sparey

articles, (Link Up Issue 26), will be very constructive in furthering my knowledge but I hope that, through this medium, I might also request assistance from anybody who has information on other screw-cutting gearboxes and on feed gearboxes as used on Brown & Sharpe and Cincinnati milling machines and on speed control gearboxes such as used on the above machines, please share your information with me. I'm interested both in the gear-trains and the selector mechanisms. I'm familiar with the Norton Gearbox selectors but I would like to receive details of others. Also if anybody can provide details of the planetary drives used in Cincinnati Milling Machines Wide Range Dividing Head the information will be greatly appreciated. Anthony D Rhodes, 2220 Rose St, Berkeley, Calif. 94709, USA. Tel: (510) 843 8416.

FOR SALE

- Foot mounted electric motor. 3/4hp 240V 1Ph 3000 rpm. £45.00 plus carriage. Tel: 0476 61204 (Lincolnshire).
- Coventry CHS 3/4 in die head £45.00. Tel: 0354 660066 (after 7pm).
- Shallow micrometer head, thimble 1 7/8in. diameter, reading 0 - 1in. in thous and tenths of thous - £25. Also a Moore & Wright micrometer head, thimble 2 1/2in. dia., barrel and thimble not divided (40 TPI screw), ball ended spindle - £20. Pat Twist, Winchester. 0962 880475.
- For sale (or exchange) New Myford 7 four way tool post, 6in. Pratt 3 jaw etc chuck with backplate. I need a 5in. 3 or 6 jaw chuck, preferably a Griptru with D3 cam lock back, a face plate and any Colchester Bantam accessories. Tel: 0780 740833.
- Myford vertical slide (£30), fixed and travelling steadies (free to caller) also set of change wheels - presumed Myford. Tel: 051 639 8948.

TWO WAYS TO PULL A FAST ONE

W.B.Taylor explains how in his professional life, he had to tax his ingenuity, and that of his colleagues, to the utmost in order to come up with practical solutions to a couple of problems

The tapered tang of an otherwise parallel shaft had seized in the nose of a solid mandrel.

Extracting it without damage posed a problem. Doodles on a pad culminated in a split-cone wedge device as used for gripping tensile test specimens or, in today's jumbo sizes, for temporarily gripping oil-rig drill-pipes. Our version consisted of two thick steel plates. One, with a central clearance hole, was positioned against the mandrel flange. The other, tapped near its ends for two hefty jacking screws, was tapered-bored on centre to match the split cone's shape. With a paper sleeve sandwiched between cone and shaft, we tightened the screws; thereby closing the cone and forcing the plates apart. The sketch demonstrates the method.

Despite copious lubrication, jacking became increasingly difficult; surely something had to give - and it did. The plates jerked, screws slackened and the shaft sagged loose in the mandrel - unblemished, thanks to the paper sleeve.

We used a modified version of the above in order to solve another poser; extracting an outer race located way out of reach, 14in. or so down a narrow bore. Merely looking down the hole proved difficult; heads created shadows, torches blocked the view, mirrors slid out of position like a house of cards and "Endoscopes" and the like were years away in the future.

Peering down the void reminded us of dentists and led us to adopt - and adapt - their technique. We took "impressions" by means of a long slender stick, suitably coated in Plasticine, thus gaining data sufficient for drawing a reasonably accurate profile of the bore's remote end and, hopefully, generating extraction ideas, too.

Clearly, an expanding puller would have to be long enough to reach the race, small enough to operate in the narrow bore's restricted space and substantial enough to withstand stresses imposed during the extraction stage.

Our, somewhat speculative, drawing showed the presence of a narrow lip due to the race's I.D. being slightly smaller than the hole beyond. We reasoned that standing the bore vertically would allow an upwards-pointing steel cone to be lowered through the race, thus rendering it possible to fill the space between the cone and lip with hardened steel balls. Pulling the cone

should jam balls and cone below the lip and, hopefully drag the race with it.

Worth a whirl! We prepared a cone, lowered it through the race on the end of a long stud, after which we added a number of steel balls, testing their effect with a tug or two on the stud. So far so good; pulling by hand met solid resistance. The second sketch shows the method.

A drilled steel plate across the bore's open end allowed us to tension the stud by the usual nut and washers. The nut tightened; so tight the ring spanner required a tubular extension. We were getting anxious about stripping threads when a crack like a shotgun almost deafened us.

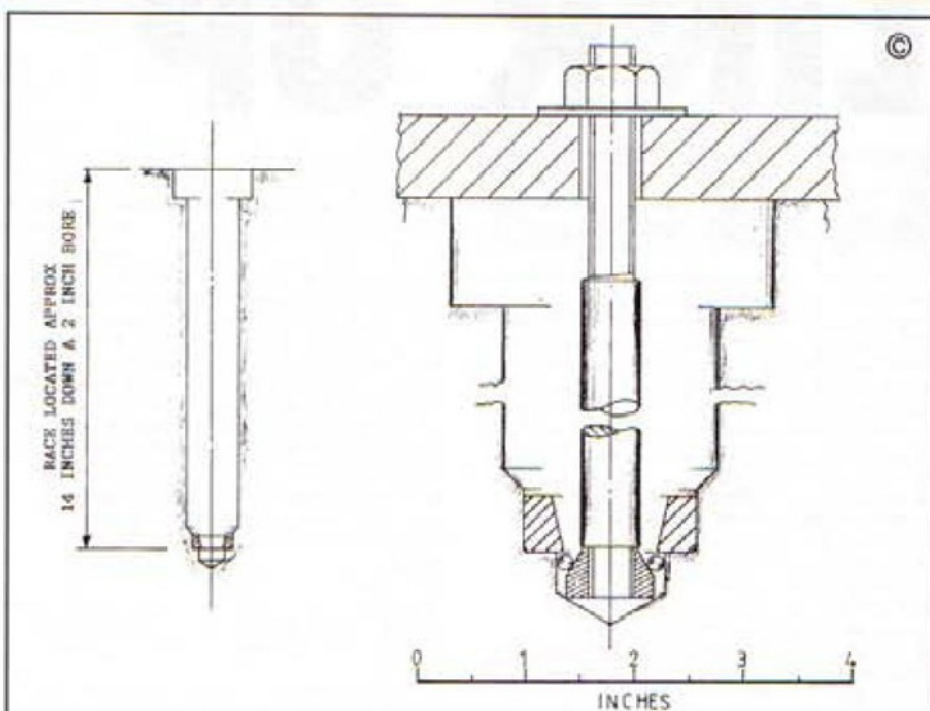
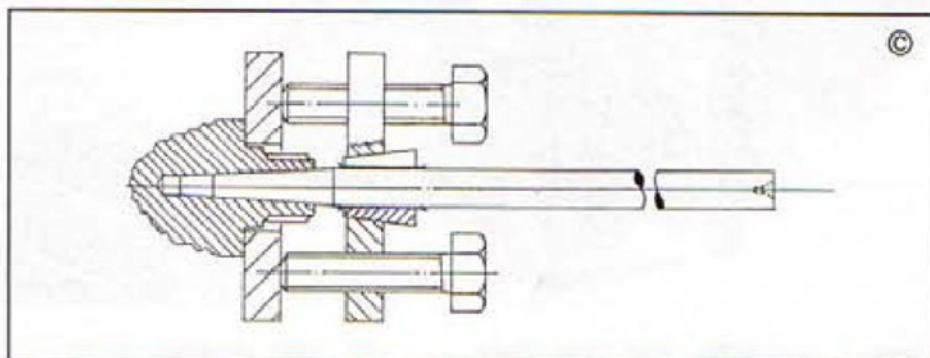
Obviously something had given way. Fearing the worst, we thought of the lip, but, as the stud resisted our tugs, threads and lip were still intact. As one finger then readily rotated spanner and nut, we decided it was due to the race being released.

Two or three full turns later the race came free, rolling out with the balls when we inverted the bore. Small wonder we heaved a great sigh of relief.

In our little book of words both schemes were noted under:

"How to Pull a Fast One".

You may never need to adopt this approach, but it could be a handy idea to pass on to someone else in the future.



BASED ON NUMEROUS PLASTICINE IMPRESSIONS WE DREW A PROFILE OF THE BORE'S REMOTE END. AS THERE WAS NOTHING TO PULL AGAINST OTHER THAN A NARROW LIP, WE LOWERED A CONE THROUGH THE RACE, FILLED THE GAP WITH STEEL BALLS AND TIGHTENED THE NUT.

TRUING DRILL CHUCKS

Have you a drill chuck which has lost its precision? Yves Rayssiguier of Brest, France, suggests a method of achieving a new lease of life for it

Having a precision drill chuck which has lost its accuracy is frustrating to say the least, even if of an average workshop quality, the thought of having to purchase another makes it worth considering a repair. I would suggest the following as a possible course of action.

If the jaws are in a soft condition we can go straight to the procedure for correcting the error. If on the other hand they are hardened, then they must be softened and the chuck must be dismantled to do this. The article in issue 22 of *M.E.W.* page 26, showed how to dismantle a Jacobs type chuck, and is covered in more detail in Tubal Cain's book *Drills, Taps and Dies*, (number 12 of the *Workshop Practice series*, published by Argus books). It should be noted that, for some other makes of chuck, typically, Black and Decker, Rohm, Taiwanese makes etc., the outer sleeve is removed in the opposite direction to that on the Jacobs chuck.

If the jaws are softened it will be, after accuracy has been restored, necessary to re-harden them. Take note when doing this that there is a risk of distortion, consequently a loss of recovered concentricity. I would suggest that the jaws are hung on a piece of wire, electric resistance wire is ideal, and heated evenly to cherry red for one minute. Quench, by lowering vertically and quite quickly into rape seed oil. Tempering can be done easily in a domestic oven.

Tool required

The tool required is a rotary file made from solid carbide. At first a cylinder tool, as illustrated in **fig. 1A**, would appear to be the type to use, but as seen later this is not suitable. A crown tool is satisfactory, but requires some modification, see **fig. 1B**, and **photo 1**.

Possible methods

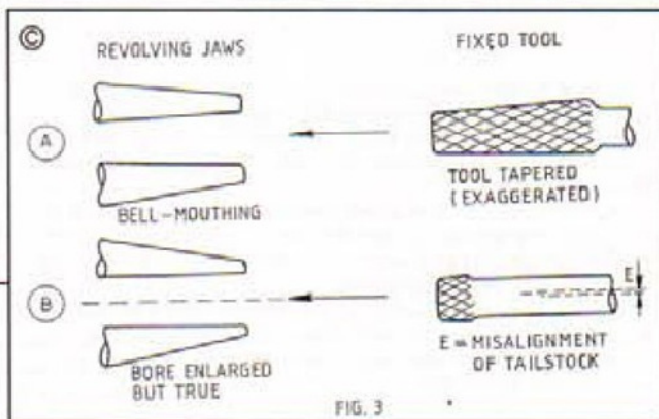
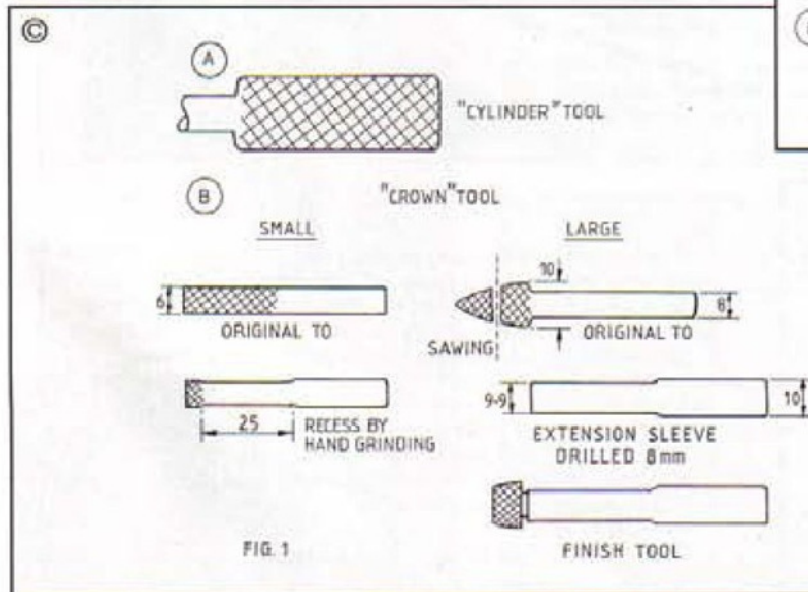
There are two ways of approaching the process, tool rotating or chuck rotating. The first would appear to be the preferred as this would permit the chuck to be progressively closed in the course of the process. In **fig. 2** it can be seen however, that using the preferred "crown tool" the end result will not be concentric if the tailstock is misaligned. With the chuck revolving, as in **fig. 3**, any misalignment of the tailstock will only result in the chuck being bored to a larger size but still be concentric. This is therefore the preferred method. In both cases the slight taper of the crown tool will be imparted to the jaws of the chuck, for this reason it is not suitable.



Method

Photo 2 shows the set-up ready to work. First, very gently, tighten the chuck being repaired onto the rotary file. Do this with the head of the cutting tool about 8mm into the chuck. Now turn the lathe by hand after which again tighten the chuck very gently. This will ensure an adequate cut is taken. Now place a fillet of Blue-tack to lock the outer sleeve to the body of the chuck, yes this does work, parts properly degreased of course, and run the lathe at about 400 rpm. Remove the tool from the chuck, then, very gradually, but without stopping, feed the tool into the chuck until it clears the rear of the jaws. The continual feed will ensure any backlash in the chuck is always taken up the same way by the pressure applied to the jaws. For the same reason, stop the lathe to remove the tool, do not run the lathe while withdrawing the tool.

At this stage, debur the jaws and



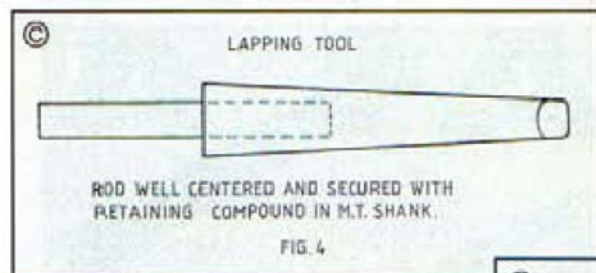
thoroughly clean out the chuck. Insert a dowel and test for run-out using a DTI. If necessary repeat the full process. For those who like a more engineered approach than the Blue-tack fillet, **Fig 5** and **photo 3** indicate a method. A plastic ring is made a tight fit on the chuck nose and its outer diameter around 6 thou. larger than the chuck body. With a Jubilee clip tightened across the outer part of the ring and the chuck body, the chuck becomes solidly locked.

For extra precision, the chuck can be, before and/or after hardening, lapped using the lapping tool shown in **fig. 4**. I would suggest using the green medium non-embedding abrasive as discussed in

Model Engineer, No. 3861 and 3909. If this operation is carried out it is essential that the tailstock is accurately aligned.

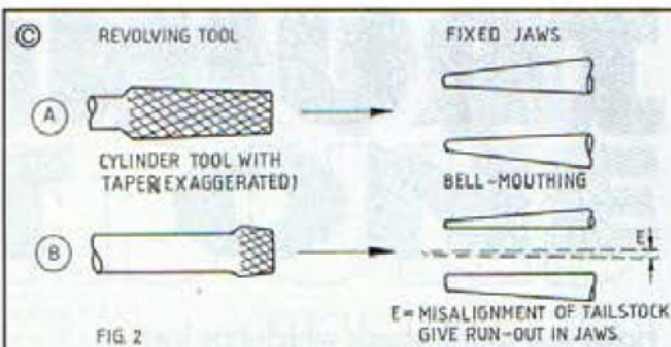
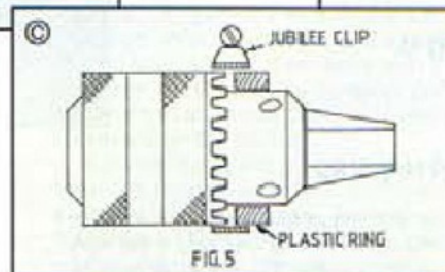
If the chuck is very old and the jaws

a small grinding point which would permit working on the hard jaws, thereby eliminating the need for dismantling and softening these. This I have tried, but never with the result I was looking for, the reasons are probably twofold. Firstly the grinding



loose in the body and with much backlash between teeth on the jaws and the inner ring, then the method may not be as satisfactory as one would wish. In this case it will be necessary to use the old method of using a reamer, in this case accuracy of alignment of the tailstock will again be essential.

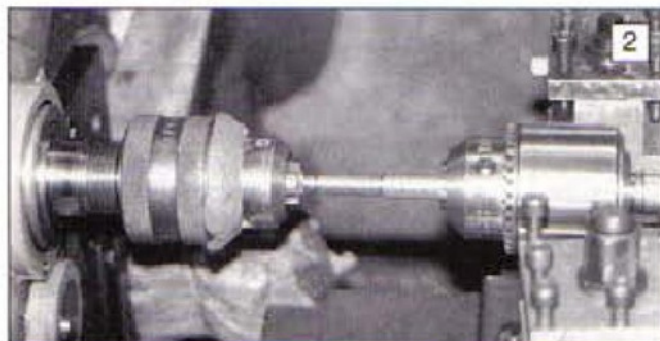
Some readers may wonder why not use



TRUEING A DRILL CHUCK

point reducing in size as the operation is taking place and, secondly, the operation places less force onto the jaws to ensure backlash is always taken up.

The method I propose above has for me produced results where the run out is less than one thou. This I feel is good enough for all applications likely to be encountered in the home workshop.

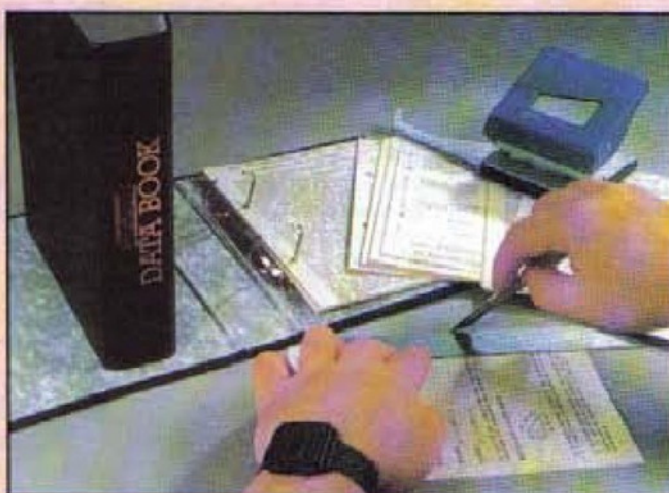


DATA FILING

With this issue we have pleasure in presenting a further eight pages of Model Engineer's Workshop Data Book information for you to collect and keep in the handsome A5 ring-binder which has been specially designed to accompany the offer.

Just the thing for handy reference in the home workshop, the pages are printed on quality card for extra durability and the binder will store several hundred sheets as the collection builds up over the years ahead.

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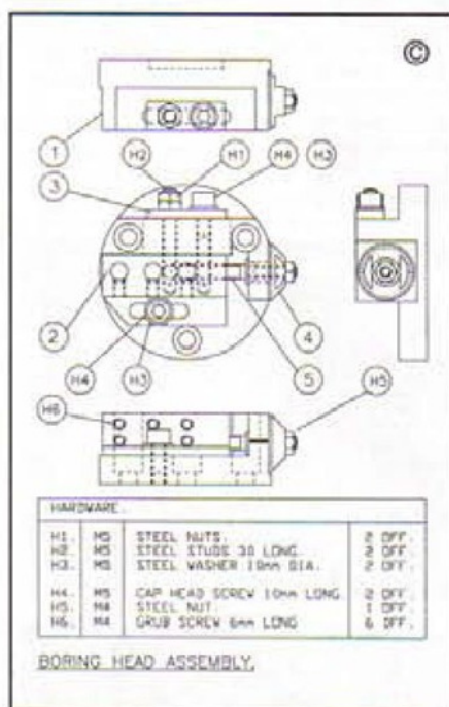
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A BORING HEAD FOR THE HOBBYMAT BFE65

John Steele has made a boring head to enable him to achieve his main aim, that is to make a machine vice. The boring head is for use on a Hobbymat BFE65 mill/drill, and because of the nature of the machine has no shank. It would not be difficult to include a Morse taper, or other shank, to enable it to be used on other machines.

The next project in my new workshop had been planned to be a machine vice for the milling machine. In fact, I had made quite some progress with this, when it was realised that there was going to be a problem regarding a requirement for a larger hole than there was a drill available.

The vice (from The College Engineering Supply) listed a 16mm operating screw thread. This well beyond the capabilities of the Hobbymat MD65 as I had not purchased a slow speed attachment. In any event, even if I made a handle for manual operation, there was no way an internal thread could be made in the vice body as it was much too big to mount on the lathe face plate. Purchasing taps and a die, also a diestock, were not considered an option on the grounds of limited future use and anticipated cost. It was found out subsequently that the cost would not have been as great as anticipated, around £10 from Tracy Tools Ltd, plus the cost of a die stock.



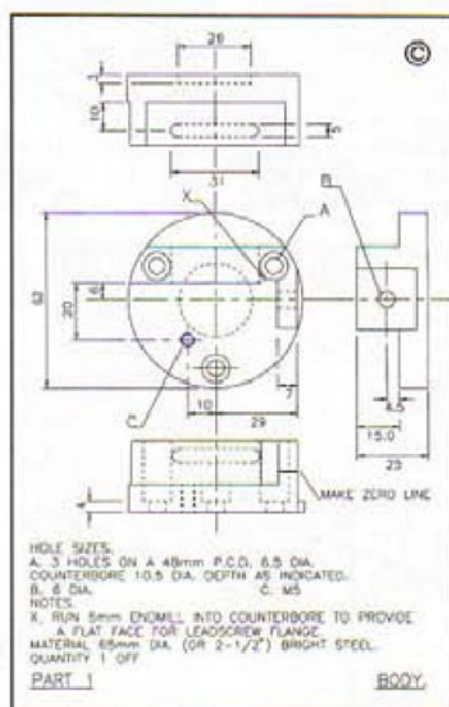
It was decided to use some M12 studding which was available and an M12 nut turned on its outer diameter to make an insert for the internal thread. This turned out to be 18mm diameter, still too big to be drilled, hence the need for the boring head, the subject of this article. It can be seen being used for this operation in photo 1.

Simple design intended

Initially, as the boring head was anticipated to have only limited future use, as simple a design as possible was envisaged. This ruled out a slide using dovetails, and at first also a leadscrew. The idea initially was to fix a block, which

1: The boring head being used for its original purpose, that is, to make a large hole for the leadscrew nut of a toolmakers vice.

2: The completed boring head.



carried the cutter, onto the rotating main portion. The cutter carrier would have slots for the fixing screws, which would be loosened the cutter adjusted using a dial indicator for reference and the fixing screws re-tightened.

Subsequently the idea was developed to include a calibrated leadscrew, but still having the Tool carrier (part 2) held in position by two fixing screws. The final arrangement can be seen in photo 2, also in more detail on the assembly drawing.

The Hobbymat BFE65 fine down feed is by means of a lead screw which raises and lowers the milling head. Lowering has the problem that it is falling under its own weight as the lead screw is rotated. This can make the down feed rather erratic. The screws which clamp the head to the column can be partially loosened to attempt to overcome the problem. Of even more significance, I consider, is that with the clamping screws loosened the head is

Hardness comparison

An easy way to distinguish silver steel from mild steel, is to use an automatic centre punch. Set the punch to strike a very light blow. The mark the silver steel will not be as wide as the mark on the mild steel, when viewed with a magnifying glass.

Robert Green



permitted to rotate slightly about the column, allowing a side to side movement. Operating the machine in this manner had a distinct feeling of not being ideal, it did however take a cut of some 0.5mm without too much problem. Looking back on the situation, it is probable that had I have inspected the hole closely, it would have been found to be oval rather than round.

After this slightly shaky start it was decided to feed the device using the quill, as in drilling. This would still have the problem of the quill dropping under its own weight, unless the clamping system was set slightly tightened, and this was done. Under these conditions the device acted like a charm, albeit the width of cut was limited to around 0.2mm at a time. Lowering the cutter via the quill rather than sliding down the column is in any case a much easier

operation to carry out.

Having made these comments I am reminded of the article on the *Mathematics of Taper Turning* suggesting that comments regarding errors and the like should preferably be quantified rather than left vague. I have therefore broken off from my writing and visited the workshop to test the extent of the left/right movement of the head when the clamp screws are left loose. The result of my tests show a total movement of 0.25mm with light sideways pressure. At this point the head noticeably becomes more resistant but will still continue to move with more force up to around 0.4mm when it comes to a stop. With the clamp screws tightened the sideways movement is around 0.01mm

When the clamp screws are loosened, the position of the head adjusted, and then

re-tightened, the head takes up the same position within 0.02mm. The obvious lesson to be learned regarding this is not to place any sideways pressure during this operation, else the head may show a variation in excess of this. These comments are in no way intended as a criticism of the BFE65. With the distance from centre of column to key being 25mm and the distance between centre of column and cutter spindle being 220mm, there is a magnification factor of 9 times. This surely is likely to be the situation with all similar design machines.

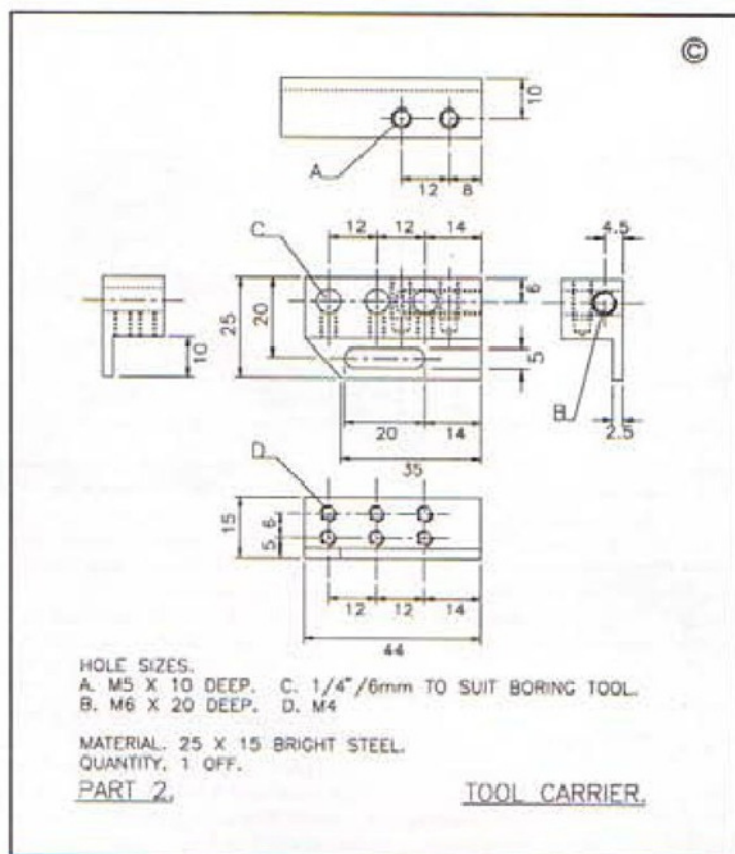
Manufacture

Making the boring head proved to be an interesting project, even though there are only two major components, three if the dial is included. The complete set of parts, except for a few screws, nuts and washers, can be seen in **photo 3**. The two major components, the body (part 1) and the tool carrier (part 2), consist of almost all milling and drilling operations, and the complex nature of these make for a range of operations, they are therefore, worthy of detailed explanation.

The body (part 1)

Considering first the body, this starts life on the lathe having both sides faced and a recess made on one side as per drawing. The purpose of the recess is for location on the milling head spindle. These turning operations require little by way of comment, other than to say that at 65mm dia. it was still well within the capabilities of the Hobbymat, as can be observed in **photo 4**.

Holding the part for milling was going to be a problem, especially as at this stage a vice for the milling machine was still not available. It was decided that by bolting it to a piece of bright steel bar, using the holes ultimately to be used for fixing it to the milling spindle, would considerably ease the problem. The body was drilled with the three holes on a 48mm PCD, and a piece of bright steel drilled and tapped on which to mount the body. The body also had some areas cut away by sawing to reduce the amount of material to be removed during the milling operations. **Photo 5** shows the assembly ready for



3: All the parts excluding nuts screws washers etc.



Lathe tools and centre height

Scribe a line horizontally around the lathe tool post at centre height. It is then a simple matter to set tool height, either with the tool post fitted or when removed from the machine. Simply pack the tool, and align with a straight edge across the permanent mark.

A.E.Higgs

mounting on the machine, and **photo 6**, on the machine table and the required milling operations at this stage completed.

It will be seen in the article yet to be published regarding the machine vice, that the clamp pieces in photo 6, were made for use when mounting the vice on the milling table. This approach to holding the part for milling proved very satisfactory, and was probably the way to do it even if a vice had been available.

The next operation was to make the 31mm x 5mm slot. Positioning such a slot can be a problem if one relies totally on the machine dials and, if a high degree of accuracy is not a requirement, working to scribed lines on a blued surface will be found much easier. The length of the slot not being at all critical, the ends were marked in this way. It may be possible to see these lines in **photo 7**, showing the slotting operation completed. Positioning the slot in the other direction was easy by touching the cutter onto a piece of paper stuck on the outer face, and then using the dials to position from there. This was sufficiently accurate, and even if a Wobbler had been available, the added involvement of setting it up would hardly be justified.

A piece of white plastic was placed between the under side of the body and the top of the angle plate to ensure the cutter did not break through and defaced the angle plate. This principle can best be seen in **photo 11**. With regard to the accuracy of placing the slot it was of course necessary for this to run parallel to the already machined surface on which the tool carrier will run. This was easily accomplished by ensuring the angle plate was at right angles to the table travel. This being achieved by means of a square located on the front of the machine table and the angle plate whilst fixing it in position. At this point, work on the body can be held while progress is made on the tool carrier.

The tool carrier (part 2)

Metric sized material to suit the carrier was not available (when will suppliers to the home workshop list metric sized materials?) so this had to be machined all over to size. Again the absence of a milling vice produce a requirement for another method of holding the item whilst being machined. In this case the material was left over length so that it could be clamped to the machine table whilst still leaving the portion to be machined available. This can be seen in **photo 8**.

Like the arrangement for machining the body, the method chosen for the carrier was probably preferable to using a vice. However, in both cases it is likely that a vice would have been used had one been available, but its absence had made me give it more thought. With the carrier sized, it was cut from the remaining material using a hack saw, and the end milled whilst the part was clamped to the angle plate. Using the L shape of the carrier, it was easy to clamp it to the corner of the angle plate to ensure the ends were milled square, not essential, but good for appearance.

The sharp edges were removed and the appropriate surfaces blued for marking out for drilling and milling (end of slot) Also the position of the slot in the body was checked to see if this had been positioned accurately, for if not, the two holes for the

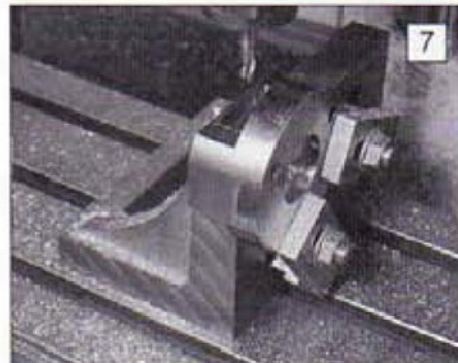
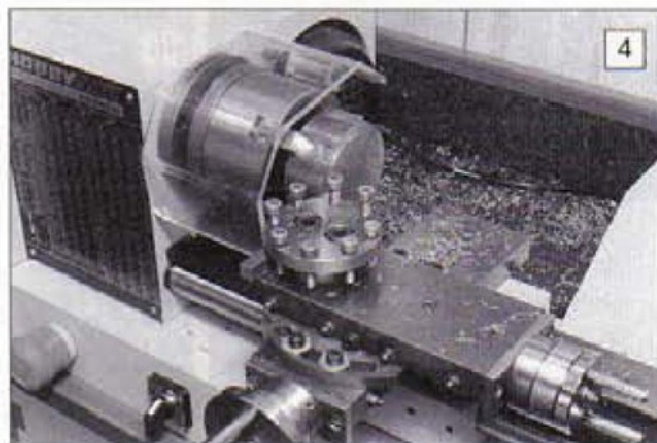
4: The Hobbymat is quite at home with this relatively large diameter.

5: The rough shaped body mounted onto a plate for ease of mounting on the milling machine table, see photo 6.

6: The main milling operations on the body complete.

7: Milling the slot in the body.

8: Shaping the tool carrier.



stud (H2) and the screw (H3) would have needed positioning accordingly. All was OK, so all holes, except for that for the lead screw, were marked out as per drawing, using a surface gauge on the surface plate as per photo 9. The part was then centre punched, drilled and tapped as required. The carrier provided an interesting range of marking out drilling and tapping operations.

The body and carrier assembly

Next stage was to drill and tap for the leadscrew. For this, the body was marked with the hole position, and using two screws at this stage, the carrier mounted onto the body. It was then set up as in **photo 10** and first drilled with an M6 tapping size hole, then followed by a 6mm hole through the body only. Much care was taken to see that the two surfaces on which the carrier slid were upright. Using the angle plate ensured one face was, the other had to be set by trial and error. If the leadscrew hole is not parallel with these two faces, then the leadscrew will bind as the carrier is moved in and out. The hole in



the carrier was tapped M6 whilst it was still mounted onto the body, the 6mm hole in the body ensuring that the tap went in true.

The carrier was removed at this stage from the body, following which the slot was machined as in **photo 11**. This picture clearly shows the piece of white plastic to protect the top of the angle plate. The plastic is about 1.5mm thick, probably a piece of engraving sheet, and being white



9: Marking out the numerous hole positions on the tool carrier.

10: Set-up for drilling for the lead screw.

11: Milling the slot in the tool carrier.

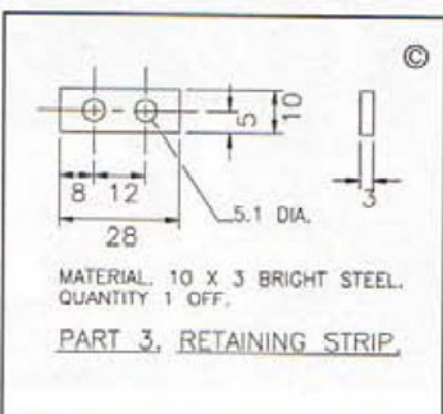
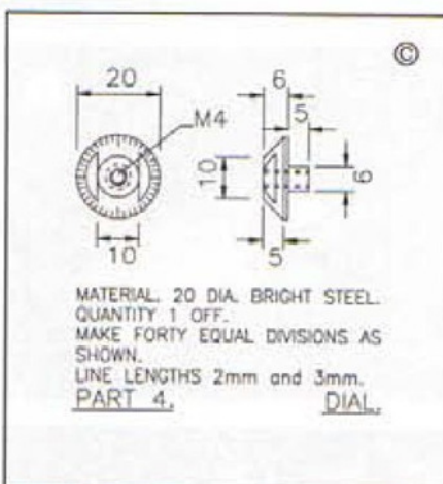
gives an excellent indication of when the cutter breaks through. In this operation also, it is essential that the angle plate is set square.

Again the carrier was fixed to the body using two screws and the position of the slot in the carrier marked through to the body, having previously been blued, using a scriber. After removal of the carrier the remaining hole (c) was drilled and tapped M5. The carrier also had its corner removed at this stage.

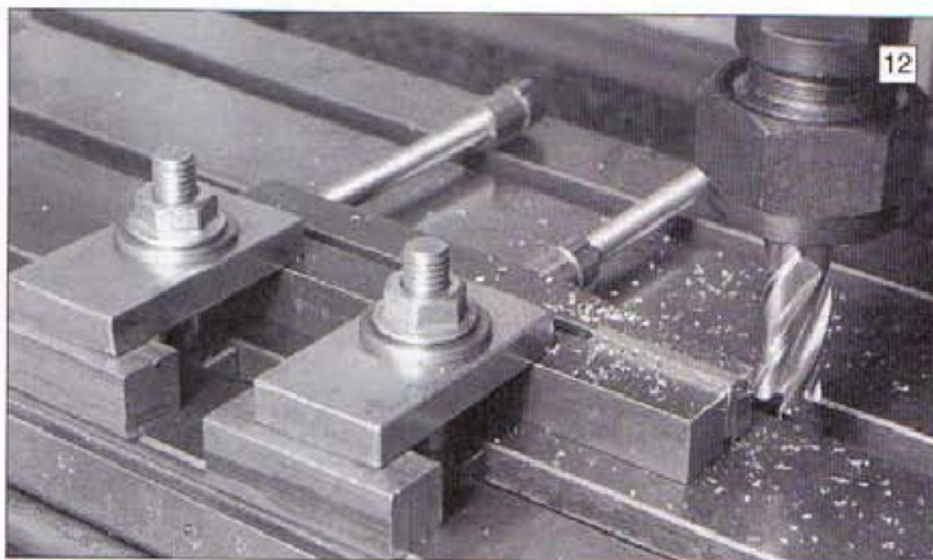
The minor parts (parts 3,4 and 5)

There remained three smaller parts to be made, but even these presented some interesting options for method of machining.

Part 3, the retaining strip, requires no explanation. However, **photo 12** show this



12: In the absence of a vice, a toolmakers clamp is pressed into service to machine to width the retaining strip. Toolmakers clamps need very careful adjustment to be used in this manner.



being reduced to width in a toolmakers clamp due to the absence of a vice. This may appear a straight forward procedure, but it does require very careful setting of the clamp to ensure the strip is being gripped equally along its length, if not, it will likely move when a cut is taken.

The dial (part 4) is a simple turning operation and really requires no explanation at this stage. The creation of the dial calibration is fairly common place, but worthy of mention if only for the method of creating the dividing strip. Many articles suggesting such an operation propose turning a disc whose periphery is exactly divisible by some easy dimension, say 5mm. It can then have a piece of steel rule wrapped around it or a length of paper carefully marked in 5mm divisions.

If some existing disk is to be used, such as the backplate of a chuck, the chance of it dividing to give a round number is very slim indeed. The method of overcoming this problem is to use the method suggested in the article on Workshop geometry published on page 13 of the June/July 92 issue of M.E.W. Example 3 of that article explains the method for dividing a given line into a number of equal divisions even if the increment is a complex dimension, in fact it is not necessary even to work out the value.

The method used in this instance is a slight variation of this method and is very easy to carry out, providing a large enough sheet of graph or lined paper is available. Even if not two pieces could be stuck together providing the spacing across the join was consistent with the lines across the rest of the paper.

A piece of reasonably thick paper was obtained and a strip around 10mm wide cut from it. This was wrapped tightly around the backplate and marked with the length required to complete one circumference exactly. This was cut to length and checked to see that it was correct. The strip was then laid at an angle across a piece of lined paper such that it precisely crossed 40 spaces and then marked at each point. This method is illustrated by the sketch published at the end of the article.

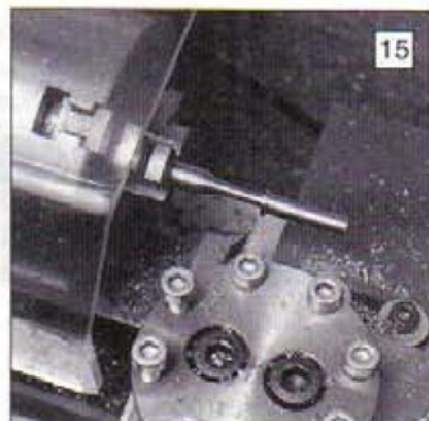
At this stage it was returned to the backplate and fixed with some transparent adhesive tape, the strip being pulled tight whilst this was being done. The result of



13: Making the divisions on the dial.



14: Using a travelling steady to machine the slender leadscrew.



15: A left hand knife tool being used to turn the smaller of the two diameters of the leadscrew.

this can be seen in **photo 13** which I feel shows the consistency of the method. A pointer was made from some adhesive copper strip and the dial cut using a sharp pointed tool laying on its side on the top slide which had been set at an angle to suit.

The method was so successful that I feel it could even be used when cutting gears for non critical applications. Of course in this case the chuck was held in position by hand whilst the line was being made, if gears were being cut some form of locking the mandrel would be required.

After the lines had all been made the top slide was again fitted with a normal turning tool and a very light cut taken over the calibrations whilst the top slide was still at the required angle. The result of this was to remove the burrs present on the lines and to give them a very precise appearance.

The two flats enable the dial to be held while the nut on top is tightened during adjustment to eliminate backlash. To make the flats, a strip of 10mm thick steel was drilled 6mm diameter and the dial fixed to this with a screw and washer. This enabled the part to be held in position on the milling table for milling the two flats.

Finally the leadscrew had to be made. This I considered required the two threads to be concentric or else the screw may bind in operation. For the same reason the M4 thread and the 6mm diameter of the dial should also be produced in a manner that achieves a good degree of concentricity.

To achieve the concentricity required for the leadscrew it would be necessary to turn both at the same visit to the lathe. As this necessitated the material to protrude from the chuck by an amount that would flex excessively under load, some added support would be required. **Photo 14** shows support being provided by a travelling steady. The method of employing a travelling steady, to my recollection, has not been detailed to date in *MEW*, but feel this is not the place to elaborate. However, I will add that the operation proved to be a very simple and satisfactory one, achieving a very good end result that would not have been easy without it.

With the larger end complete (perhaps this was the wrong end to start) the smaller end for the M4 thread was turned using a left hand tool. This stage of the manufacture is illustrated in **photo 15**. The M6 thread was then made with a die prior to parting off the leadscrew, it was then turned round in the chuck and carefully held on the M6 thread whilst the M4 thread was made.

Assembly

Having completed all the parts, they were deburred, or in some places chamfered by about 0.5mm, lightly oiled where appropriate, and assembled. The final result was very satisfying, not least because it was an original design. As mentioned at the start of the article it functioned very well for the purpose it was originally made. Adjustment to the diameter being cut is achieved by slightly loosening the two cap screws and turning the dial using a 7mm AF spanner on the outer M4 nut.

The three cutter positions together with the adjustment make it possible for it to be used at any diameter up to about 60mm. Whether the slowest speed (315 rpm) available on the BFE65 will be slow enough for this diameter only time will tell.

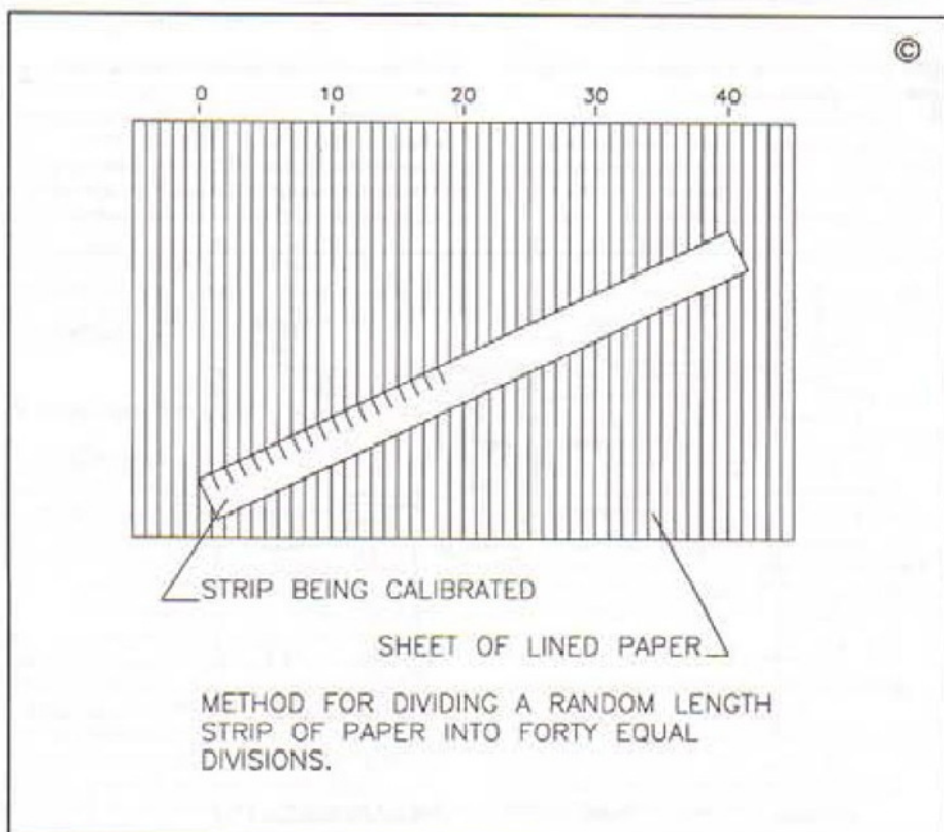
With the boring head completed, it was now possible to continue with the already started toolmakers vice, another early project which was proving to be very interesting.



0.125mm Shimstock source

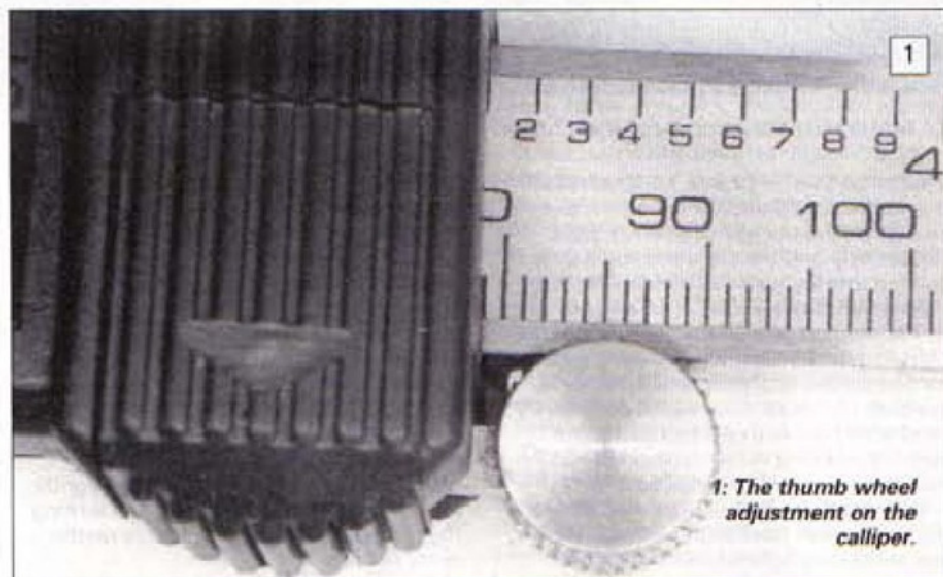
A useful source of aluminium shimstock 0.125mm thick is empty drinks cans. The walls are easily cut with scissors and it is a free material. As many drinks contain some acid it is wise to wipe them over on the inside surface with a damp cloth and allow to dry before use.

B.Lilly



ADDING A FINE FEED TO A DIGITAL VERNIER

Surprisingly, it would appear that, digital Verniers cannot be obtained with a fine feed adjustment as is supplied on many conventional Verniers. Bob Loader has gone up market and acquired a digital vernier and finds the absence of a fine feed its only real disadvantage. Being Bob, he has set about adding his own and explains how in this brief article.



1: The thumb wheel adjustment on the calliper.



3: The block and thumb wheel looking from underneath.



2: The original retaining block end thumb wheel.

For my birthday this year my wife gave me a digital calliper.

Compared with the vernier calliper I have had for a long time, it has obvious advantages. It will do all the measuring which the old one does and it saves a lot of mental arithmetic and cancels out one

source of error, because it shows exactly what the dimension is; on a conventional vernier there could be an error of a couple or hundredths of a millimetre or the equivalent in inches built in as a reading error. The other great advantage is having an immediate conversion from inches to

millimetres at the touch of a button, a lot of my work has to be a mixture of the two. Now I can leave my vernier set up as a height gauge with my home made modifications, the hassle of taking it apart every time I need to change from measuring to marking, or vice versa, is in the past.

So, it does everything as well as, or better than, the non-digital one.

4: The components of the fine adjustment.

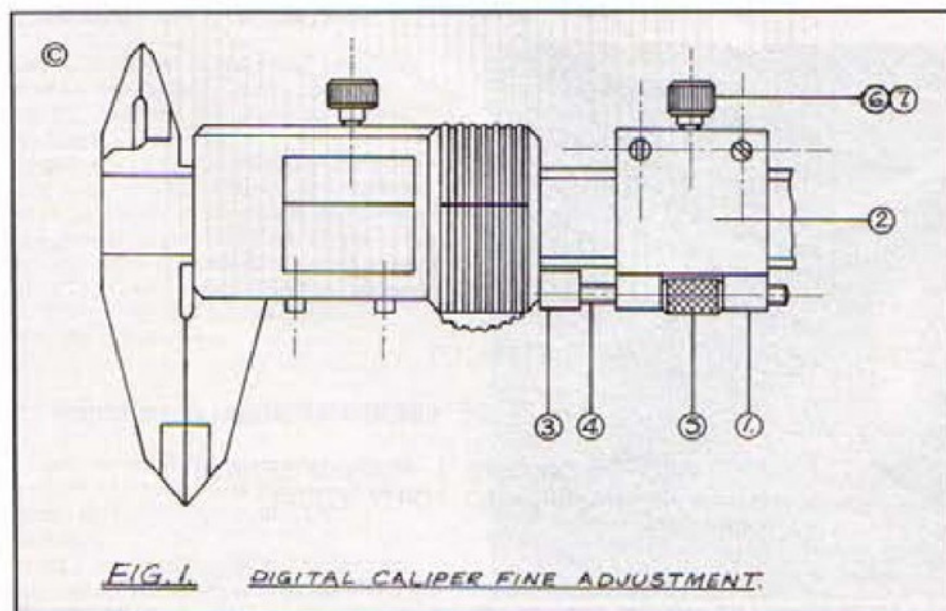
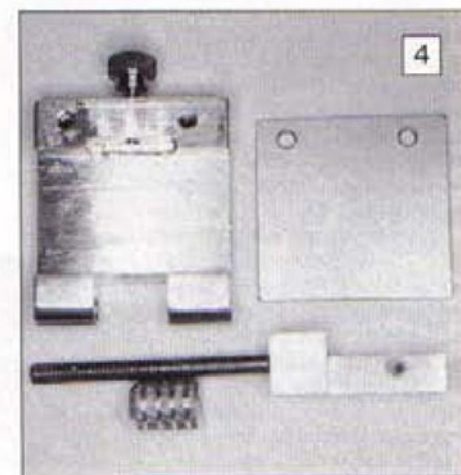
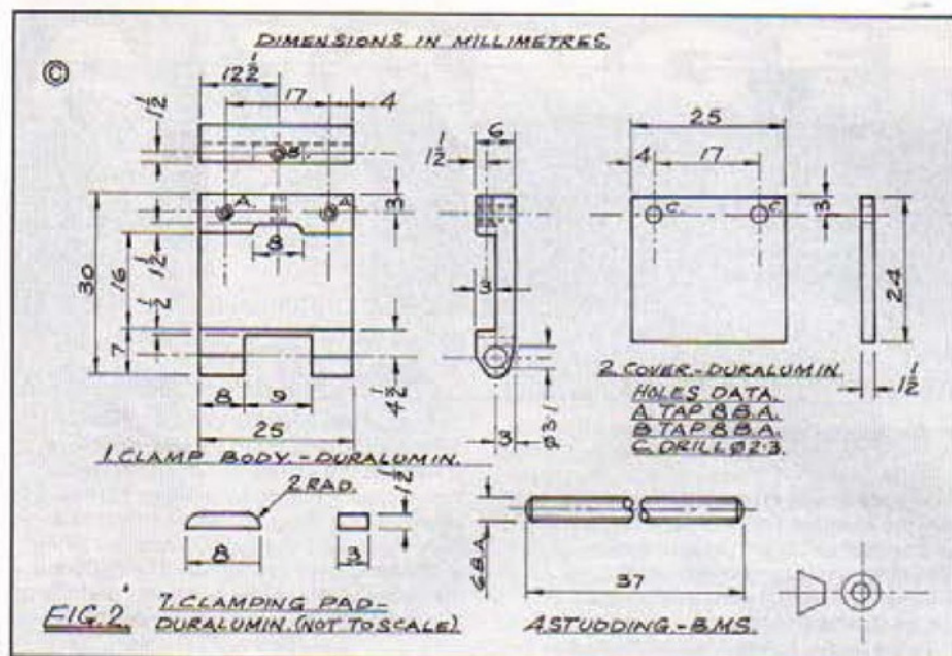


FIG. 1. DIGITAL CALIPER FINE ADJUSTMENT.





The clamp body

I usually start the job with the piece which will be the most work, or the one which is likely to be difficult. In this case it was the clamp body shown in Fig. 2. As it would need bit of accurate filing, I used Duralumin, which files and cuts easily. I had a piece 25 x 6 x about 120mm long. I left it in the length because it is easier to clamp and operate on, if it is left long. Confucius, that good friend of engineers, had a saying for it, 'Foolish man cuts to length first: wise man leaves it in a lump till he has done all the cutting and drilled all the holes'.

Marking out was simple, the important dimensions are the width of the cut out to fit the calliper beam, 16mm and the depth to fit same, 3mm (These dimensions refer to my calliper, if you are doing this work on your machine it would be prudent to check it to ensure that the dimensions agree). The easiest way to cut this 16 x 3mm slot is to mill it.

However, as it is a bit of a chore to set the Unimat up for milling, I filed the slot. It isn't as difficult as it may seem, because the bulk of the metal, being Duralumin and easy to cut, can be chiselled out. I sawed parallel slots between the 16mm lines, stopping short of the 3mm depth. If the saw cuts are quite close, the chisel doesn't have too much to do; I use one with a cutting edge about 3/16in. wide, narrow enough to be very useful in restricted spaces; it made short work of the roughing out. A 10in. 2nd cut square file did most of the filing, followed by an 8in. 2nd cut pillar file, which is 15mm wide. I used second cut files in each case because they are coarse enough to shift the metal without pinning too much and the safe edge on the pillar one is useful.

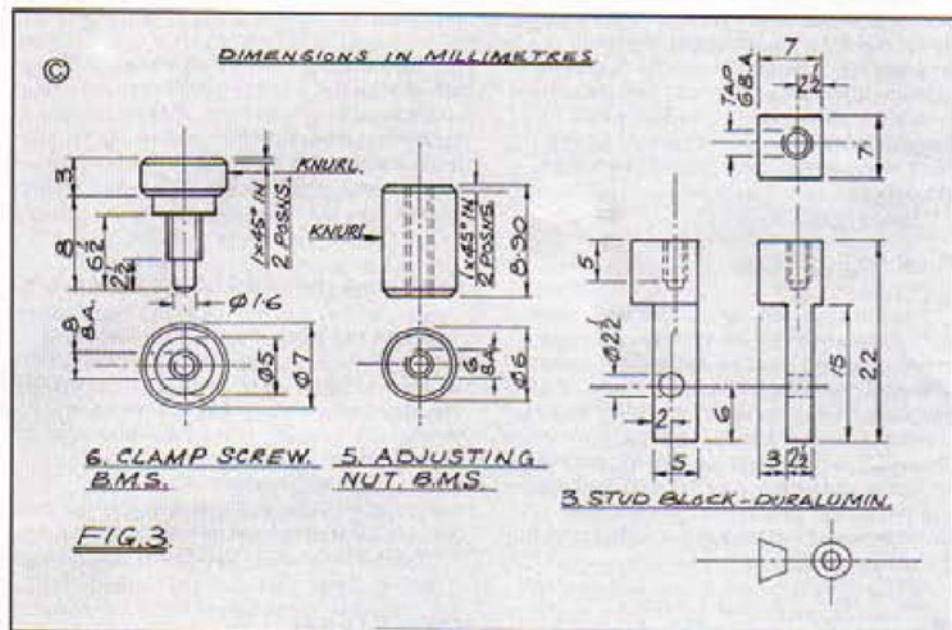
To make sure that the 16mm dimension was accurate, I clamped a fence to the work, lined up with the marked line. A piece of square mild steel stock does the job. Do not use hardened steel and don't make it too small, it has to act as a guide, so 6mm is the smallest which will do the job. Once one edge was finished, I worked on the other one with a 4in. smooth hand file, with a fence to get the vertical edge right.

Fitting the clamp

It probably wouldn't matter if there was a bit of clearance on the fit of the clamp to the calliper beam, but I like a nice fit, so I fitted it by trying it on the beam. Getting the depth right was a bit more taxing and needed careful checking with a micrometer. If 6mm material is used, 3mm is the figure to aim for and even done carefully, it will probably show a blemish somewhere. Mine does, as a look at photo 4 will confirm; a mark where the saw cut was a bit too deep and wouldn't clean out. Luckily, it doesn't show when the job is assembled. Final fitting comes later.

Milling the clamping pad socket

The small cut out or pocket in the clamp body has to be milled, it measures 8x1 1/2mm and accepts the clamping pad, item 7, Fig. 2. It is another optional component and could be left out, but I



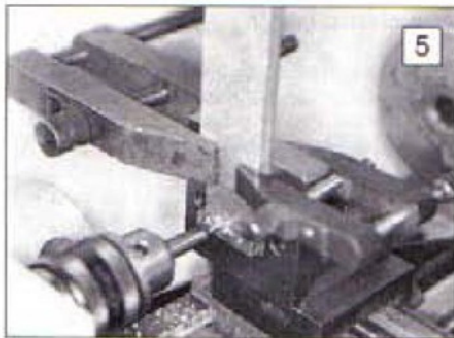
Everything? Well, there is one small thing which the non-digital does much better. It has a fine adjustment second to none. The digital has a frictional arrangement in the form of a thumb wheel, shown in photo 1. The small block which holds the wheel in position and the wheel itself is shown in photo 2. Looking at both photos gives an idea of how the arrangement works. The thumb wheel has a small recess which allows it to make a frictional contact with the land on the vernier beam and prevents it from overlapping too much. It is not as sensitive as the conventional vernier adjuster. I've looked at a lot of digital callipers and many more in catalogues and so far, they all have the thumb wheel. It seems that you can get them with solar cells, infra-red remote control and even a connection for connecting to micro processors, the only thing you are unlikely to find is one with a sensitive, easily used, fine adjustment.

I'm not a compulsive fiddler with things, or one of those who must have things to pieces as soon as they get them home. I follow the philosophy, 'If it isn't broken, don't fix it', but circumstances alter cases and I explored the possibilities of making a better fine adjuster. It was surprisingly

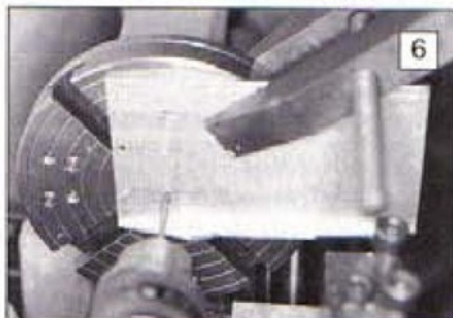
easy to get at the block which holds the thumb wheel and remove it, without doing any damage. The fixing is in the battery compartment. When the cover is slipped off and the instrument turned upside down, all is revealed as in photo 3. The thumb wheel is held by a small shaped block fastened by one screw. When the screw is undone, the block and thumb wheel can be removed.

A little design work

Once it was clear that something could be made, it was just a matter of making some sketches taking in the important dimensions. Most of the pieces to be made are quite small and the materials easy to find. There is no need to use the same materials as I have, I only used them for convenience. The pieces as I made them are shown in photo 4. Check before working to my dimensions, there could be differences for different makes of calliper; the most likely ones in the shape and dimensions of the block which holds the thumb wheel. This block holds the studding which does the adjusting on the modification, so it needs to be right.



5: Milling the pocket for the clamping pad.



6: Milling the holes in the cover, note that the material is left oversize for ease of clamping and the hole positions are marked in pencil.

don't like a screw clamping directly on the calliper beam. The pad will protect it.

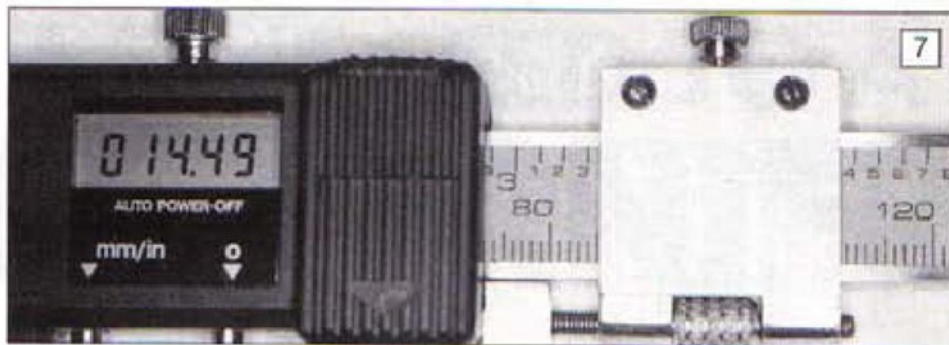
The milling is straightforward, I used a $\frac{1}{2}$ in. slot drill, which is near enough 4mm; **photo 5**, shows the job clamped and the milling underway with the job left in a lump, just as Confucius suggests. It is my normal milling set-up, an angle plate clamped to the Unimat cross slide, set true, and the job set vertical with a square, resting on a parallel on the lathe bed. The cutting position is sighted against a scribed line and the Pocket is milled till the cutter just touches the filed surface. Remember to lock the saddle for each cut.

Drilling the clamp body

The cross hole for the 6BA clearance is drilled by clamping the 6mm strip to a larger block, clamping the assembly to the angle plate and positioning the hole centre with a ground point or a small centre drill held in the drill chuck. If you have a drilling machine, then forget all the palaver and drill normally. The tapped hole in the upper surface of the clamp which takes the clamp screw, **part 6**, can be done in the same fashion.

The cover

With the clamp almost finished, the cover can be made. Duralumin was the chosen material again, the 1mm thickness isn't too important, but it shouldn't be thinner. Do the marking out for the holes in pencil, the rest of the cover can be marked with a scriber. Use a nice sharp pencil and the lines won't show when the job is finished. When the cover has been shaped and drilled, it can be clamped to the body and the holes spotted through. **Photo 6** shows the Mk 1 cover being drilled. I intended to use, four screws, but found that two were enough,



7: The completed fine adjustment.

so the Mk 1. was discarded. Notice again, that the material was left large for the drilling and cut to size later, it makes clamping and setting much easier.

When the holes have been spotted, they can be drilled and tapped

in the body. I chose 8BA because it looked small and neat and I had a couple of round heads which were chrome plated. Be careful when tapping and use the *smallest* tap wrench you have; more small taps are broken by too much leverage than any other cause. It is a good idea too, to use a tapping drill a size bigger than the book size, so that it will be a bit easier on the nerves.

Final fitting

The 9 x 6mm cut out in the clamp body can be cut and filed, then body and cover assembled and tried on the calliper beam. However carefully it has been made, it will probably need a bit of easing. Mine took a little work with a fine file to get it to slide nicely. Once it does, the clamping pad can be made and fitted. It will need checking again with the pad in position and the cover screwed on, to make sure that the fit is still right.

Clamp screw and adjusting nut

Fig.3 shows the rest of the components. I haven't specified the type of knurl for the screw or nut, it isn't easy for me to knurl because the only one I have is a full sized one. I managed to press hard enough to get a sort of pattern on the nut and supplemented it by turning some vee grooves in the finished nut, see **photo 4**. It would be a reasonable way of making a grip without using a knurling tool. The drilling and tapping of the nut was no problem and the chamfers were done with a vee tool when the grooves were cut.

The best way to make the clamp screw is to adapt an existing one if a suitable one can be found, I had one with a straight knurled head which didn't need much alteration. If it has to be made, it should be possible to file fine grooves in the head to form a fine straight knurl. A straight knurl looks better because it matches the existing locking screw on the instrument.

Stud block

This is the most awkward piece to make and its dimensions *must be thoroughly checked first* as the dimensions I have given in **Fig.3** are those which fit my

calliper. They could be different for different makers. So to be safe, the block should be drawn and dimensioned first, just in case, I started by making a 7mm square 22mm long, drilled and tapped it 6BA, using only the taper tap, so that the stud would jamb up tightly. Then I drilled the 2mm hole. Only when all the drilling was done, did I file the rest of the shape.

Studding

The studding I used was a long 6BA screw with the head cut off, trimmed and chamfered to 37mm long. It was a steel screw and was cadmium plated, so it looked right. The 37mm was the length I cut it to end, within 5mm each way, not important.

Checking the stud block assembly

Screw the studding into the stud block till it jamps. Then take the original thumb wheel and block off end replace them with the new block and studding. Leave the screw half tight and slide the clamp over the studding. When the clamp slides nicely, tighten the screw and fit the adjusting nut. If the clamp won't slide, the 3.1mm, clearance hole can be opened up a bit, but no more than to 3.25mm.

Final touches

Go over everything and de-burr. Be generous; you are going to handle it. the clamp body end cover are Duralumin, they will take a good finish without too much trouble. The radius at the bottom of the clamp is made to blend in neatly. the shape is up to the maker. **Photo 7**, shows the completed fine adjustment. It doesn't look unsightly and it works a treat, makes measuring and setting a lot easier and does no damage to the instrument.

Cutting compound and corrosion

When cutting paste or compound is used on a machine tool, i.e., for drilling holes, screwing in the lathe, on the milling machine etc., all traces should be cleaned off tables and slides after the job has been done as most compounds contain corrosive chemicals. The job, too, should be thoroughly cleaned upon completion.

Alan Jeeves

A TANGENTIAL SKIVING TOOL

Ron Bentley provides an article on what I feel will be a process unknown to almost all readers of MEW. He illustrates the process by making a Morse taper.

When I was being trained as a multi-spindle auto Setter, 45 years ago in a small factory with only 3 autos, the preferred tool in that shop, both for accuracy and smooth finish, was the Skiver. Later I moved to a much larger shop and found the Skiver was unknown there! It was not until much later, when I had been promoted to "Planner and Tool Designer" that I saw another one. I decided to write this short account of the tool in case there are other machinists who have not encountered it, as I think it has a lot of potential for use on centre lathes, particularly those with long cross slides.

To describe the Skiver and its use I shall take as a workpiece a 1/2 in. diameter by 2 in. long cylinder. Much more complicated outlines are possible, but this will serve as an introduction. In **fig. 1A** the end view of the bar in the chuck is shown, with the Skiver just contacting the outside diameter of the bar. The toolholder and cross-slide are not drawn to keep the drawing uncluttered. The tool, attached to its toolholder and cross-slide, travels forward with its cutting edge tangential to what will be the outside, finished, diameter. It cuts as it processes until it reaches the vertical centre line of the bar, and can cut no more because at this point it passes into "fresh air". With this tool, the accuracy of the finished diameter does not depend on arresting the tool at a predetermined position, as does a form tool, but only in the Skivers cutting edge having passed the vertical centre line. In the conventional

terms as applied to tools, the near horizontal face is the "front face", and the near vertical face is the "Top rake".

Refer now to **fig. 1B** where the Skiver is shown in plan view, as it first contacts the bar. Note that the cutting edge is not parallel with the outside diameter, as a form tool would be, but at an angle, the "Shear angle". Because of this shear, only a small part of the width of this tool can be cutting at any instance, in contrast with a form tool which would cut on its whole width, in this example 2 inches. From the point of first contact by the tool, the width of the band of swarf being cut increases until the first point crosses the vertical centre line. At that instant, the width of swarf being cut is from the end of the job up to where another part of the cutting edge has just contacted the bar, as in **fig. 1C**. As machining proceeds, the band of cut moves along the bar, the appearance of the swarf being rather like peeling an apple. The typical appearance of this narrow swarf be seen in **photo's 1 and 2**. In **fig. 1D**, all of the cutting edge has passed the vertical centre line and the machining is completed. The narrow band of swarf cut imposes a low stress on the tool and the job. We choose the geometry, when designing the tool, to control this swarf width. The larger the shear angle, the narrower the swarf band. The less the material to be removed, the narrower the swarf band.

Returning again to **fig. 1A**, a line is drawn from the bar centre to the first point of contact by the tool, and extended across the tool, to indicate the top rake needed. i.e. If the tool were to be made with the top rake drawn, it would commence to cut with zero top rake, which would increase as the cut progressed to a maximum as the cutting edge crossed the centre line. It is advantageous to rough off as much of the surplus material as possible before skiving, as we are then not compelled to use an unnecessarily large top rake, although still

being able to start the cutting with some top rake. A little easy mathematics will define the rake and shear angles most suited to a component of this diameter. Diagrams **Figs. 2 & 4** carry the story forward.

Fig. 2

In this the top rake triangle is shown. Side (a) is the radius of the bar. Side (b) is the tangential distance traversed by the tool in cutting. Side (c) is the radius of the finished component. Using Pythagoras's equation, $a^2 = b^2 + c^2$. Then side $b = \sqrt{a^2 - c^2}$ and $c/a =$ the cosine of angle B, which is the top rake needed to start the cut at zero top rake. There is no virtue in zero rake and we may choose to increase this angle if circumstances are favourable.

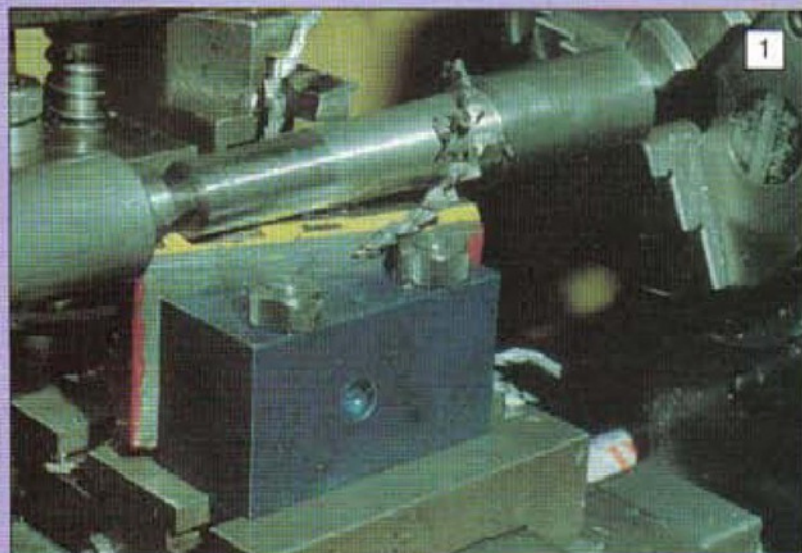
Fig. 3

This is the shear plan angle extracted from **fig. 1B**, and in the right angled triangle: Side (a) is the shear side. Side (b) is the tangential distance traversed by the tool in cut, and it has already been

Parting off lubricant

If your lathe is not equipped with a coolant system and you intend to part off work with the parting tool, tapping fluid or paste can aid the cutting operation and help to reduce chatter.

Alan Jeeves



calculated, see above under fig 2. Side (c) is the width of the swarf being machined off (b). The tangent of angle B = b/c and angle B is the shear angle.

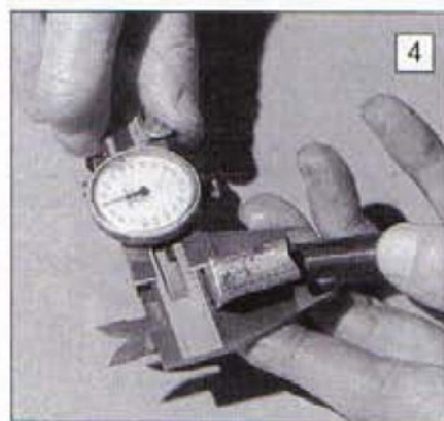
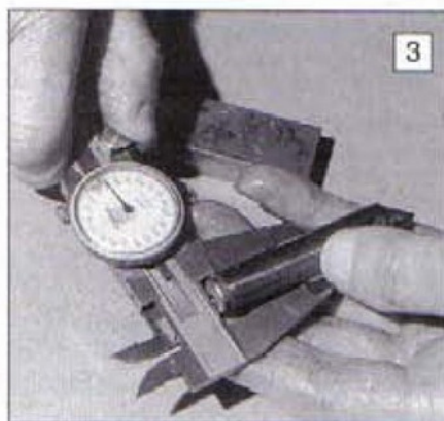
Fig.4

Using the 3/4in. dia. example, (and these data apply only to this diameter), I have calculated the tangential length of cut (b) with finishing allowances on the radius from 0.005in. up to 0.020in.; the top rake that each would need; the shear angle needed to cut swarf band widths from 0.100in. up to 0.500in.

From inspection of the above table, it is clear that the most favourable conditions result from a low finishing allowance, and every effort should be made to get down to 0.005in. or smaller on the radius to ensure that a moderate top rake will suffice. There is more choice with the shear angle. With a large angle, and a wide component, the cross slide travel needs to be large also. While this may give no trouble on centre lathes, particularly those with a long cross slide, Automatics may only have a slide movement of 1in. and the

shear angle has to be limited, though I have entered the calculated shear angles to a decimal place, they should be rounded up to whole degrees. On a centre lathe, the tool holder for a Skiver is plain and simple. It may be a solid block, or small angle plate. It has a vertical face slewed round at the shear angle, on to which the cutting tool is clamped. The height, including the holding down screws, must be able to pass underneath the rough turned bar. I always fit a tenon to the base, so that the holder with its tool in place may be removed from the slide and replaced with accuracy. These toolholders are so cheap and easy to make that many tools can be attached permanently. I always keep one set up for a 2 Morse taper, ready to make an occasional tool shank. Make tool holders rigid and sturdy. There is scope for toolholders with a second mounting face behind the first one, so that additional tools may be used. Besides the means for clamping the tool onto its

holder, it is necessary to provide two height adjusting screws, as widely spaced as possible, for tool height. Used singly they correct the taper or parallelism, and in unison the diameter. Lock nuts are required. These screws may be part of the tool or the holder, whichever is most convenient. 4BA screws are adequate, (38.5TPI, = 0.026in. per turn). The cutting tool may be a piece of mild steel plate, with a rebate in the top edge to accommodate a piece of tool steel, fixed with silver solder, tinmans solder, or Araldite. These tools are low stressed, and this type of construction answers well. For long



Screws for screw jacks

Take an M20 bolt, 25mm long and drill & tap it M10 straight down the centre. Screw an M10 x 25 mm long set screw in from the tail end and you have a good screw jack packing for the milling machine. You can of course make them any size you like.

Alan Jeeves

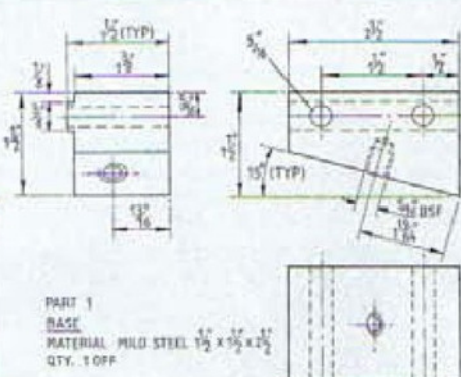
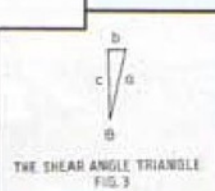
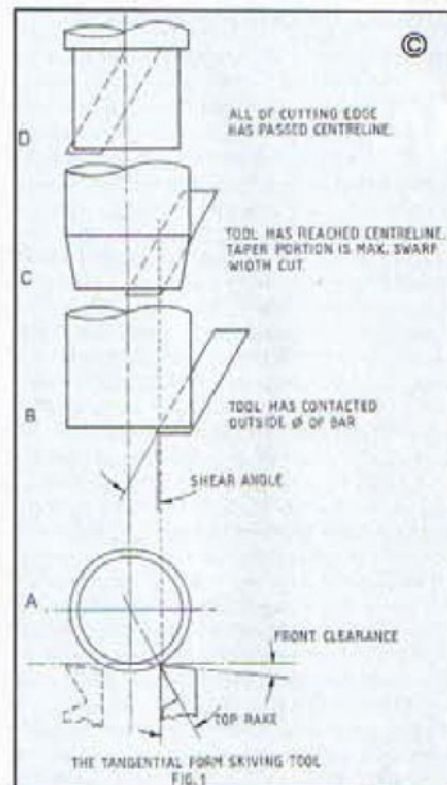


Fig. 4.
Table of finishing allowances, top rakes and shears to cut swarf widths. For 3/4in. diameter (finished) only.

finishing allowance on radius (in.)	tangent length of cut(in.)	Top rake (deg) commencing at zero	Shear angle (deg) to cut swarf width of: in.				
			0.1	0.2	0.3	0.4	0.5
0.005	0.061	9.3	31.6	17.1	11.6	8.7	7
0.010	0.087	13.1	41.1	23.6	16.2	12.3	9.9
0.015	0.107	15.9	46.9	28.2	19.7	15	12.1
0.020	0.124	18.3	51.1	31.8	22.5	17.2	13.9

Grinding wheel cushions

If your grinding wheels are not provided with paper labels which act as 'cushions' between the wheel and wheel flange, the most suitable material for making them is blotting paper.

Alan Jeeves

components, a single piece of tool steel is essential, but where the form is not continuous, two or more pieces may be used. It is a good way to use up all those short ends of good HSS left when turning tools become too short. The tool blank must be set up at the shear angle for grinding the form through unless it is a simple straight edge one. Tools for automatics and other heavy, rigid, machines, need only $\frac{1}{2}$ in. of front clearance, but for our typical amateur's centre lathe 1in. of front clearance is advisable. There is no need to compensate the form. I will just mention at this point, but without going into details, that ordinarily form tools need compensating for the adverse effects of top rake and front clearance, and if this is not done, then the form machined will not turn out as accurately as expected. The Skiver is virtually immune to this. On good machines, the Skiver can produce large numbers of well finished and accurate parts. Surface finish of 10 micro-inches or better, and runs of thousands are commonplace. When working with brass or light alloys and carbide tools, 30,000 pieces without re sharpening the tool has been achieved. Because so little of the length is being machined at any time, long components may be worked with little difficulty. Tailstock or other support may be needed. The longest job I ever had to tool up was 8in. long, $1\frac{1}{2}$ in. diameter, parallel to ± 0.002 in. and that was on an automatic, with no support possible. I hope that I have aroused your interest sufficiently to tempt you into trying one of these tools. If so, start small, and work up. The cone seats of some pipe fittings, or the opposed cones of compression olives,

perhaps. A batch of collets for a new attachment or tool? Morse taper shanks, ball ended levers, serrated hose inserts, boiler hand rail knobs and anything else needed in fair quantities. Your skill at tool grinding is all that limits the possibilities; if you could make a form tool then a Skiver is no more difficult. An excellent finish on the tool should be the target, but this would be the case if you were making a form tool.

As I said at the start, I have never met anyone to add to my basic knowledge of these tools, and I do not consider myself an expert in any way. Is there anyone else out there with his bit to add? Please come forward, for I fear it may become a lost art if you don't.

A method for machining No.2 Morse taper Shanks

Now that you have a general understanding about the use of the Skiver on centre lathes, I will narrow the field to the specific task of producing a one off, or a batch of taper shanks; No.2 Morse taper in fact as I am tooled up for them, and need a few blanks which will enable some pictures to be taken. "Killing two birds with one stone" as the old saying goes.

The Morse size is not of any great importance anyway as the simple tool is very adaptable to the different ones. The drawings show a typical Skiving tool and its holder, and the assembly.

Firstly, we need to establish some data to work with. The diameter of a No.2 at the small end (The plug line) is given in tables as 0.572in. which is a radius of 0.286in., and if we add 0.005in. for the roughing this becomes 0.291in. radius. Applying Pythagoras equation as in fig. 2 produces a tangential traverse of 0.085in., and the rest of the calculation yields a top rake angle of 10.6deg., which I rounded up to 12 deg. top rake, as that rake is about right for steel. That was in fig.2. Applying the calculations connected with fig. 3 yields a swarf width of 0.2in. at a shear angle of 15degrees. This looks very promising!

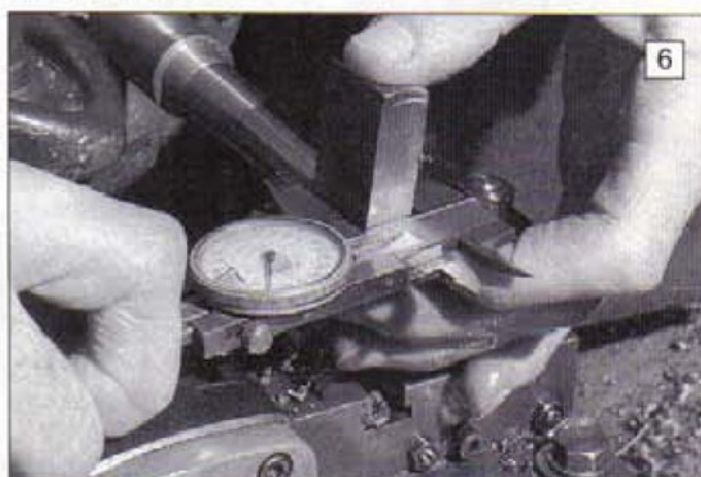
Now take the hard centre from the lathe and apply the Vernier gauge, as in photo 3 so that the back bar of the gauge is in contact with the end of the hard centre. Read and record the diameter shown by the gauge where the tips of the jaws reach. Repeat this procedure with a spacer of known size interposed between the gauge and the end of the hard centre. This is shown in photo 4. The spacer I have used is 1in. wide. Tables of data tell us that the

taper of a No.2MT is 0.049951in. per inch of length and with my equipment, eyesight and feel, this is 0.05 in. per inch. With the 1in. spacer I used, the difference between the two readings of the Vernier was 0.050in. and this confirms the accuracy of my hard centre. If your spacer is not of an exact length it does not matter; multiply the length of the spacer by 0.050 in. and that is the difference to expect from your Vernier readings. Set the top slide of the lathe round to $1\frac{1}{2}$ degrees and insert a suitable piece of bar in the chuck. Face and centre the end, and if it is much oversize, turn it down to a generous oversize for the required length. Using the angled top slide, rough out an oversize taper, and when it is long enough, repeat the tests with the Vernier and the spacer on it, as was done with the hard centre. This will reveal if the taper is correct. If it is far out, adjust the top slide and recut. The amount of oversize being left may be ascertained by comparison with the sizes recorded for the hard centre, and for setting up purposes only it is well to leave a generous allowance for trial outs. Clean off the cross slide and fit the Skiver and its holder. Set the left hand end of the tool in its correct position and lock the main slide. Ensure that the tool and holder will pass under the blank without touching, and raise it carefully by its adjusting screws, interposing a piece of thin card so that the delicate cutting edge does not become damaged by contact with the stationary bar. Get it to conform with the taper as best you can, and return the slide to the rear position. Always return the slide to the rear before raising the tool as it will not pass the bar without damage otherwise. Raise the tool by the thickness of the card used in

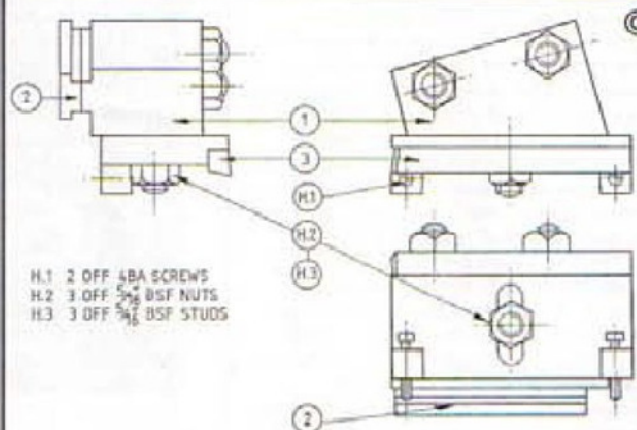
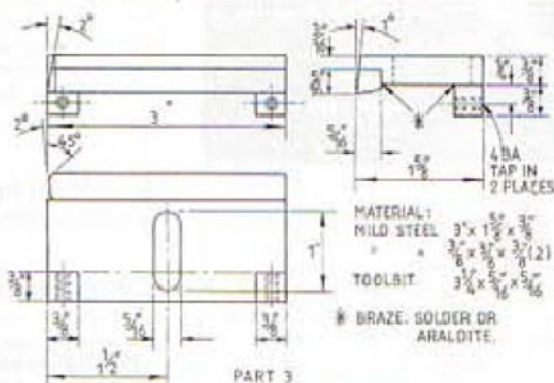
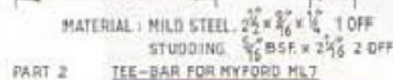
Grinding wheel dresser

A small grinding wheel dresser can be made from an old and damaged knurling tool wheel which is mounted in a holder and allowed to spin freely while the holder is supported by the work rest.

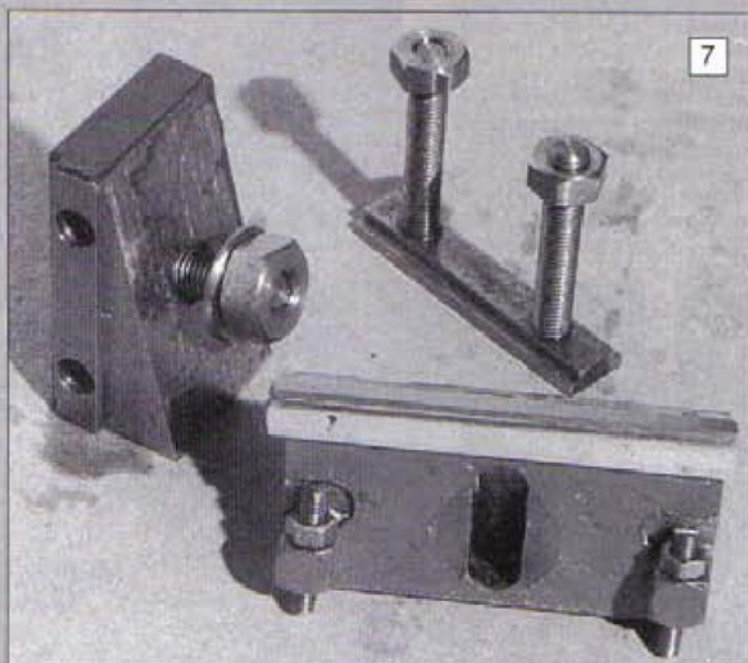
Alan Jeeves



When producing a batch of Morse Taper shanks, the procedure for the second and subsequent ones may be varied slightly, so that two cuts, a roughing one and a finishing one may be taken. After taper turning, but to a size much nearer the finished size than when setting up, the main slide should be moved further away from the headstock and locked up for the first skiving cut. When this has been taken, the component may be gauged to determine its oversize. With a taper of 0.050in. per inch for a No. 2 Morse taper, this is equal to 0.001in. per 0.020in. of length. So, for every 0.001in. that the blank is still oversize, move the slide 0.020in. towards the headstock end. With this degree of control, it is possible to leave just a thou. or so for the final cleaning up cut. Happy Skiving



ASSEMBLY OF TYPICAL PLANE SKIVER & HOLDER



When cutting paste or compound is used on a machine tool, i.e., for drilling holes, screwing in the lathe, on the milling machine etc., all traces should be cleaned off tables and slides after the job has been done as most compounds contain corrosive chemicals. The job, too, should be thoroughly cleaned upon completion.

54

AN 'EASYSET' TAILSTOCK DIE HOLDER

Clive Washington comes up with this delightfully simple method of ensuring that threading dies can, with ease be repeatably set to cut correct size.

Over the years I have gathered quite a wide range of screwing tackle, mostly cheap surplus; a large range of taps, and rather fewer dies. In fact it struck me recently that I actively avoided using dies for a range of reasons; not only were they rather expensive, but I always had some difficulty in adjusting them to the required size. Perhaps the most serious problem was that I had never bothered to make a tailstock die holder, preferring to use a hand die stock, which I guided using the jaws of the tailstock chuck. Not surprisingly this sloppy method of working often produced unsatisfactory drunken threads.

This situation was forced to a head by the need to cut some 10 and 12BA threads, and it became clear that my existing methods were going to cause a lot of frustration, if I didn't provide the right equipment for the job. I had over the years toyed with the idea of making George Thomas's tailstock tap and die holder; for those of you who haven't seen this design, it gets over the problem of setting the die by giving each die a separate steel housing in which it can be pre-set to size. I didn't like this for a number of reasons; it involved a lot of work turning up the die holders, and more importantly I felt that it put too much mass of metal around the die, which would lose the sensitive feel that is needed in the smaller sizes. However, it was evident that I could not make an ordinary die holder without tackling the setting problem, or I would only have done half a job.

I spent some time considering the possibility of calibrating each die by measuring the number of turns through which the opening screw had to be turned; on some dies, however, I had to close the die to get it to cut to size, so this method seemed to be a non-starter. I then realised that when the die was adjusted to a given size, the die gap would always be the same. If it were possible to measure and set the die gap, the die should be adjusted to a repeatable size. This seemed a promising method since the gap, being near the circumference of the die, should change by a relatively large amount compared to the opening of the thread near the die centre. Again, after a few trials, I abandoned this idea, since the gaps on some of the dies were rather ragged, and it wasn't easy to gauge them repeatably with a feeler.

I then hit on the idea that the ideal thing to measure would be the die diameter since, if the thread were opened by 0.001in., then the die diameter would also enlarge by exactly 0.001inch. The only

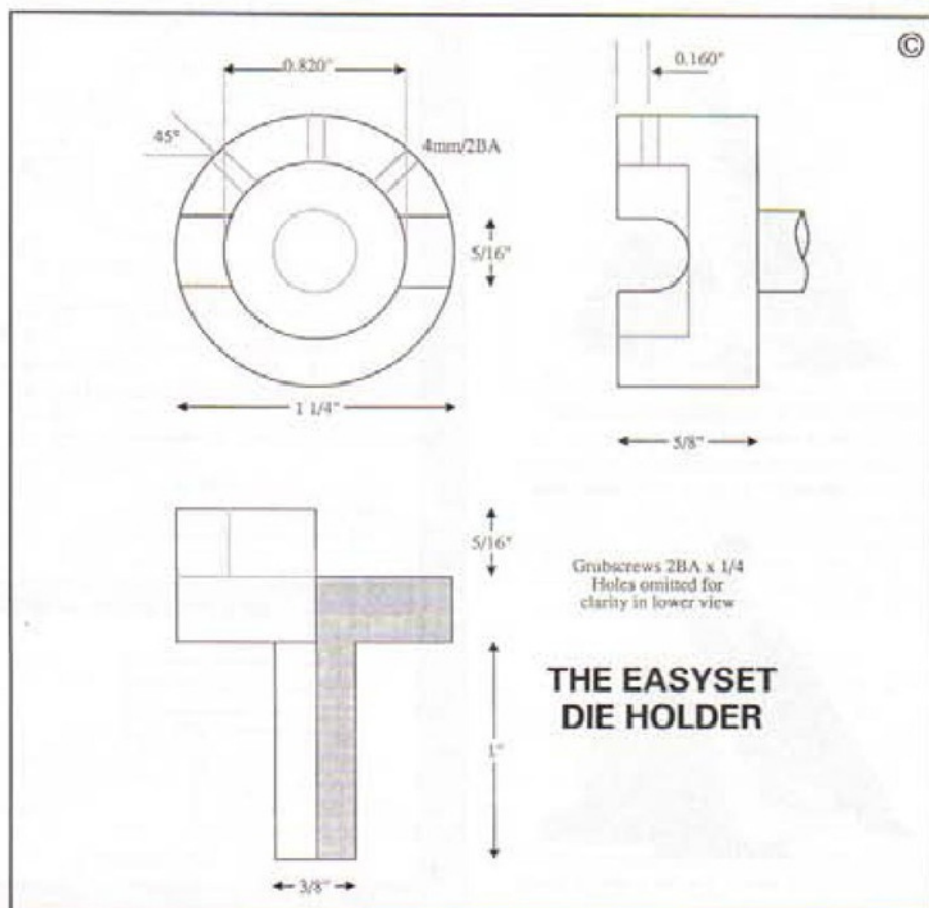
problem is that you generally can't get at the die to gauge it when it's in a conventional holder. So, why not mill a pair of slots in the holder to allow micrometer access? I had never seen a die holder like this, but it seemed that the holder would not be unduly weakened. The resulting holder (Fig. 1) was produced; this is a version for $\frac{1}{8}$ in. dies, with a $\frac{1}{8}$ in. stub for my sliding tailstock adaptor, but can be easily adapted to suit the equipment of the individual worker. It was a straightforward turning job; the slots were milled with the side of a $\frac{1}{8}$ in. dia. end mill, which provided enough clearance for my micrometer (M&W 961B) but you should check that it will allow your own micrometer to fit. The adjusting screws might cause some problems; I marked their position very carefully using a die as a reference and I reckon I was lucky to get them right first time, without holding the die drunkenly. They should bear slightly on the lower edge of their holes in the die, so that they force the die squarely into the holder. Making the holder is only the first half of the problem.

We now have to set the dies accurately to a standard thread. In my ignorance I made a thread gauge by hand tapping suitable holes in a strip of BMS, and adjusted the die to make a thread that fitted these holes. Unfortunately the thread then

refused to accept a commercial nut! Of course, what I had done was that, despite my care, my hand tapping had made sloppy loose threads, so the die was adjusted oversize. I made a second set of thread gauges by tapping drilled discs in the lathe, and these then came out OK.

To adjust a die, a piece of BMS is chucked and turned to the appropriate OD. The die is placed in the die holder with the outer screws fully backed off, and the centre screw tightened to open the die. The thread is then cut and tried in the gauge. The die is closed and the thread run over until the gauge goes on easily but without shake; as this is done, the closure of the die can be checked in small increments by simply measuring with a micrometer. When the correct adjustment is made, the die OD is measured and the reading noted. A permanent record can be kept in a notebook, or if you have an engraving tool, the size can be engraved on the die. When you next need to use the die, insert it in the holder and open it to the desired size by micrometer. If you work carefully you can even adjust the die for a measured amount of clearance. For the small amounts of work I do, die wear does not seem to be a problem.

I've been using this system for a few months now and can confirm that it produces good, close-fitting threads every time.



THREE WAY TOOL POST

This article is from the pen of the late Dave Lammas. Dave considered, that the advantages of the three way tool post, outweighed the disadvantage of the loss of one tool position, when compared with the four way post. Made from a small casting which can be obtained from a well known supplier, this tool post will provide an interesting little project for beginner and expert alike.



1: The Lammas Three Way toolpost loaded with raked tools for cutting steel and aluminium.



2: Another similar toolpost loaded with zero rake tools for cast iron and brass. Note One home made holder is loaded for carrying triangular tungsten carbide tips.



3: This version is loaded with a set of tools for right hand cutting.

Before you start to say "Oh no, not another gimmicky toolpost" let me state that this design has now been in use by me for a long time and by friends or other model engineers in this country and abroad for almost ten years. I have yet to hear of anyone who has tried the system wanting to go back to the awkward old fashioned 4 way toolpost with all its drawbacks. In fact one user in Australia was kind enough to write in *Model Engineer* magazine that the designer of the 3-way toolpost should have been awarded a knighthood for the greatest advance in lathe design for many years. Perhaps he should have written to some other department because I never did get that knighthood. At a display a few years ago the toolposts were shown together with a notice saying "Better than a 4-way, quicker than a quick change". Perhaps at this stage the advantages should be briefly explained. It is well known that the biggest defect of the 4-way is the fact that the following tool fouls the work under certain conditions of use. This means in effect that separate shaped tools must be used for each type of operation, for example a tool used for plain turning cannot normally also be used for facing cuts. If the toolpost is rotated slightly to bring the turning tool into position for facing the following tool immediately fouls the turned portion. With

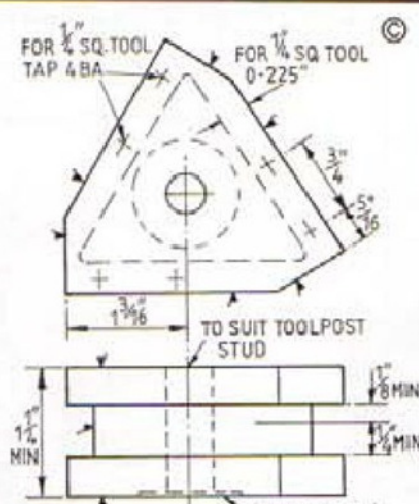
the 3-way toolpost there is ample clearance even when it is rotated through quite a large angle.

It will therefore be appreciated that although holding one less tool it can perform more operations, in addition anyone who has caught their hand on a sharp cutting edge with the 4-way type will be pleased to know that with the new system there are only two cutting edges to watch out for instead of three.

Taking the other point regarding speed of use; it is readily seen that a toolpost holding 3 tools can be changed over more quickly than the complete removal and replacement of the single quick change type. There is another important aspect to consider here as well, how many individual quick-change holders do you need to buy to get best use from the system, they are not cheap.

Summarising the advantages of my method we can say

- 1) Less danger of accidental injury.
- 2) Fewer shapes of tool do more work.
- 3) Fouling of workpiece does not occur.
- 4) Fast interchange of tools.
- 5) Cheap to use because the simple casting can be machined entirely on the lathe with which it will be used.
- 6) Because it is cheap we can afford more than one toolpost. Thus the first is loaded with raked tools for cutting steel or



DIMENSIONS OF TYPE A
THE SMALLEST SIZE SUITABLE
FOR 3 1/2\"/>

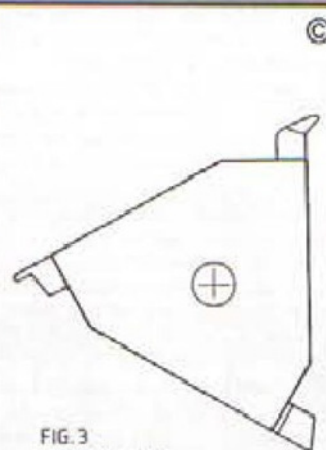
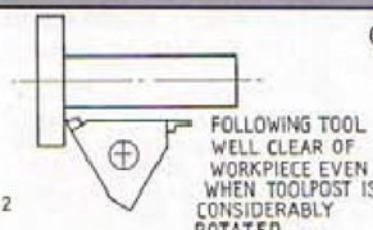


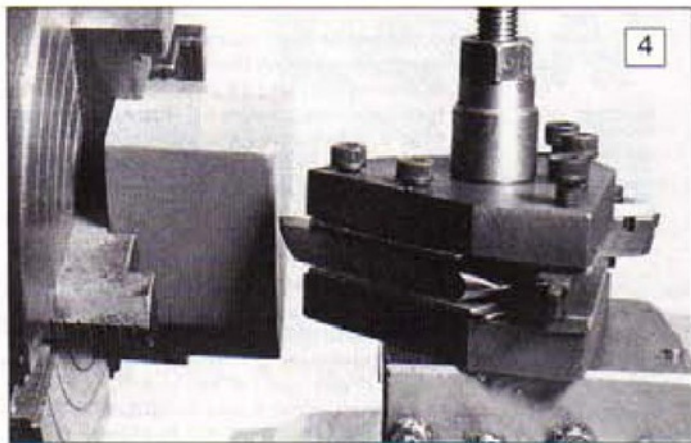
FIG. 3
VERSION FOR
RIGHT HAND TOOLS
TO CUT & FACE TOWARDS
THE TAILSTOCK.



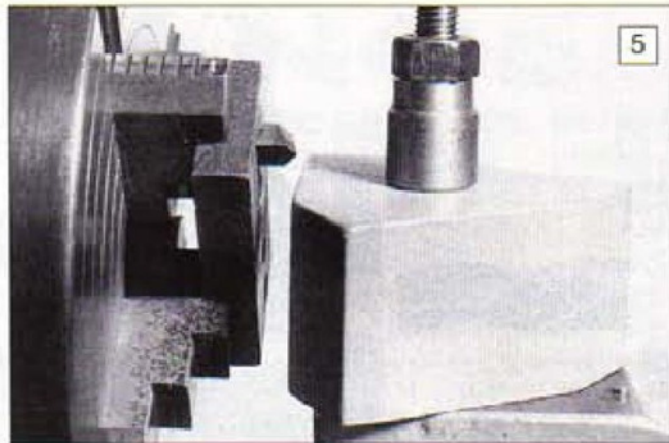
OBSOLETE 4-WAY TOOLPOST



SUPERIOR 3-WAY TOOLPOST



4: Facing the casting in the chuck, using a HSS tool set in a previously made three way toolpost.



5: Flycutting the faces of the casting, which is mounted on the topslide.

aluminium, the second is loaded with zero-rake tools for brass or cast iron.

7) By the same token, one toolpost can be machined 'upside down', meaning that it will then hold tools for cutting towards the tailstock.

8) Need another for tipped tools? No problem, just order another casting.

By now I reckon even the most sceptical reader should be admitting there may be something to it after all. If still doubtful just ask someone who has used it for a while, it is a fairly safe bet they wouldn't go back to the bad old ways.

In the first place the idea was developed for my own use but after it had been seen by fellow model engineers requests to 'make me one' came thick and fast. Mine was designed for an ancient 3/4in. Winfield lathe which is of similar size to the Myford ML4 and the Zyto. Soon I had to design a larger version to fit the Myford ML7 and similar lathes. The casting supplier now stocks three sizes A, B and C. A is the original, B fits ML7 and C is the largest for the Boxford lathe or similar machines.

Construction

The casting as received is fully shaped but needs machining on all surfaces as indicated on the G.A. drawing. The overall size is not critical, just taking off sufficient to clean up is usually enough.

Facing

Grip the casting firmly in the 4-jaw chuck, top outwards with the base resting against the face of the chuck. Take a roughing cut to remove the skin from the cast iron then take at least one more cut of around ten thou (0.010in.) to achieve a good finish.

Reverse in the chuck pressing the newly machined face hard against the chuck body and repeat the treatment, this leaves top and base flat as well as parallel to each other.

Marking out the central hole

The diagram for this operation shows where to scribe the lines with respect to the finished dimensions of the toolholder. All drawings refer to type A toolholder only, as detailed drawings are supplied with the castings. When scribing the three lines allow for the fact that at least 1/16in. will have to be added to the 1 1/16in. dimension. In any case it is quite easy to see if the lines

cross at the centre of the casting. Don't just rely on two of the lines crossing or errors can easily arise, just like in navigating a small boat in choppy waters when compass bearings are apt to be slightly out.

Having found the centre, 'pop' it with the centre punch then drill through to suit the toolpost stud of your lathe, making it a close though free fit. The recess around the hole at the base is to ensure that swarf does not get trapped close to the stud which would result in insecure clamping. The recess does not have to be accurately concentric with the hole so just set it up in the chuck 'near enough', remove about 20 thou (0.020in.) or so to a diameter of roughly 1 inch.

Machining the sides flat

This can be done, either by flycutting or end milling. Place the casting on the topslide using the toolpost stud to clamp it down. It is a good idea to first of all turn and bore the special clamping collar, (Spacer, fig.5) to be used with the toolpost. Like recessing the base its shape makes certain that a firm grip over a good area can be guaranteed, you do not want the toolpost shifting during machining any more than when it is in use for its legitimate purpose.

The endmill or flycutter can be held in the lathe chuck. If it only cuts over a smallish diameter, say 1/2in., it will be necessary to take several cuts with different sizes of packing under the casting. Turn upside down to complete the coverage. A larger diameter flycutter can do the job in one pass. The various sides of the casting are readily aligned parallel to the face of the chuck by placing a rule across the jaws then moving the saddle until one face of the casting traps the rule.

Milling the tool slots

When all sides are machined flat bring one side up against the tailstock centre to scribe a short line along it indicating lathe centre height. Now decide what size of lathe tool you intend using. Years ago I bought 1/8in. square tools which were reasonably cheap at the time, but as prices increased I changed over to 1/16in. square tools, which are perfectly adequate for model engineering purposes. There is four times as much steel in a 1/8in. tool as in a

1/16in. one and the only benefit of the larger size is that it conducts heat away from the cutting edge more quickly. This might be a factor to consider in industrial work aiming for maximum rates of metal removal but is irrelevant for most of our jobs. So far as rigidity is concerned 1/16in. size has always proved to be satisfactory.

Whether deciding upon 1/4, 1/8 or 1/16in. square the rule is that the top of the tool should be at lathe centre height. As the cutting edge is ground lower in successive re-sharpenings the tool is raised a corresponding amount by thin packing strips below it. At least 1/16in. should be allowed above centre height to accommodate this movement.

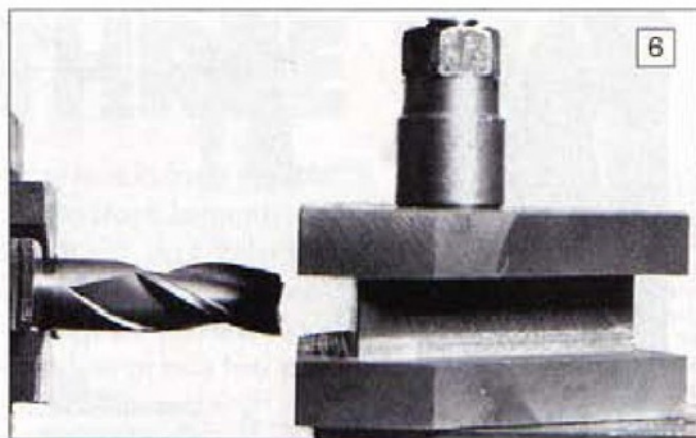
Therefore another line must be scribed on the side of the toolpost blank 1/16in. or so above the line already made, then a third line is scribed below centre height equal to the thickness of the tool. It is only necessary to do this on one side since all three slots will be milled one after the other at the same setting.

If a slot drill or end mill the same size as the slot is available just place packing beneath the toolpost sufficient to raise it so that the end mill coincides with the slot position. Set the casting parallel to the face of the chuck and tighten down firmly. Since large forces are generated when milling do not attempt to cut the slot in one pass but take a series of shallow cuts around 40 thou (0.040in.) at a time, this will minimise the risk of movement by the toolpost.

The total depth of cut should be about 25 thou (0.025in.) less than the width of the lathe tools to be used. It is a mistake to have the slots too wide.

Where an endmill smaller than the slot is being used it will be necessary to pack the toolpost up in stages. Take the metal out with series of cuts as described above, then place more packing below and take a second series of cuts, or more, until the slot is completed. Retain the packing pieces so that the other slots can be dealt with in the same manner.

Completion of a set of toolposts intended for turning steel, brass, etc., as well as one for right hand cutting, is facilitated if they are dealt with as a batch. For instance, face the top and base of all castings before proceeding to flycut the sides. Flycut them all before milling the slots. Do not forget to turn the 'right hand' one upside down before marking out and milling the slots!



6: Cutting the tool slots. This is carried out using an end mill in the chuck. The casting is raised on suitable packing.

Tool clamping screws

The old 4-way toolpost was often fitted with square headed screws which are rather clumsy looking, some modern toolposts are fitted with socket grub-screws thought by some to look quite neat as they lie flush with the surface of the toolpost. Think again about these because they invariably fill up with fine swarf that is not easy to remove, their designer should have foreseen that fault. The best method is to use socket cap-screws which being clear of the surface are far less likely to accumulate swarf. Get some that are not too long though. If using $\frac{1}{4}$ in. square tools in slots milled for that size only it will be bent to employ 4BA cap screws. If 2BA were used the holes would be too close to the edge. 2BA is the ideal size for larger slots.

Only two screws per slot are drawn, which is enough for new or only slightly worn tools. If you want to use short ends of HSS another hole must be drilled and tapped between the existing ones.

Indexing stop

I have not drawn this item partly because I do not use one but also because readers wishing to replace their old 4-way toolpost will already have part of the mechanism attached to the topslide. It might then be possible to adapt this to the new 3-way posts or at least to make similar new parts that will fit in.

As mentioned earlier one of the big advantages of the 3-way system is that the toolpost can be used at various angles to the topslide giving greatly improved versatility. It does not always have to be at right angles to the slide. The conventional indexing stop mechanism would probably interfere with this feature. An adjustable stop designed to catch one corner of the toolpost can be fitted to the top of the topslide if ability to return to a pre-set position is deemed essential for certain operations, such as making large numbers of small screws for instance.

The tools

Careful selection of a few basic tool shapes will enable one to perform the majority of turning operations without too many tool changes.

A knife tool, round nosed tool and

recessing or small parting off tool will handle most jobs. I like to use a more substantial parting tool in a rear toolpost in any case, so perhaps the small one could be replaced by a roughing tool. Loading the steel, brass and right-hand toolposts with a similar selection will go a long way towards speeding up ones lathe work, leaving more time to concentrate on the interesting parts of the task instead of constantly hunting for odd tools of assorted rake angles then wasting time setting them up.

There is no reason why another toolpost

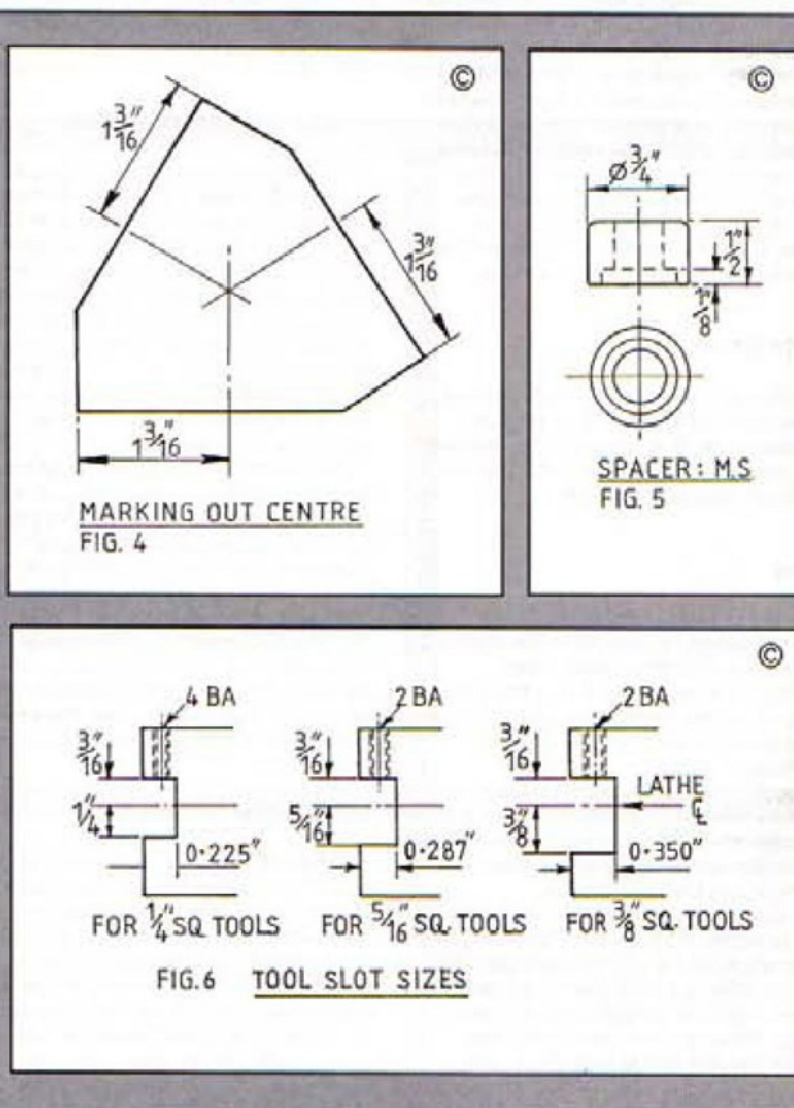
could not be kept loaded with boring tools or maybe a boring tool, an internal recessing tool and an internal screwcutting tool. Likewise an external Vee screwcutting tool, a square thread tool and a chamfering tool already to hand would be very useful, there is plenty of scope in this system.

Storage of toolposts on a rack consisting of short lengths of $\frac{1}{2}$ in. dia. steel set in a wooden block adjacent to the lathe also helps to speed things up, the tool for the job can be selected without having to think about it and changed instantly. How often have you attempted to do a job with the wrong shape tool just because it happened to be fitted in the 4-way turret and it seemed too much trouble to change it? When you manage to get away with bodging things in this manner it may seem alright. When the job goes wrong and you have to start again from scratch with the other tool, you begin to wish things were better organised. I believe my toolposts will meet this requirement in an entirely satisfactory manner.



Casting supplier

Blackgates Engineering, 209 Wakefield Road, Drighlington, Bradford, West Yorkshire, BD11 1EB. Tel 0532 853652. Fax. 0532 853477.



A LOW RANGE TORQUE WRENCH

Geoff Oakes, of Box Hill, Australia, provides this interesting project with a useful end product

I prefer to do my own servicing and minor repairs on my automobile. I have a torque wrench with a range of 12 to 160 Newton metres (Nm) but the need was felt for one with a lower range. This article describes the construction of one with a range of 2-16 Nm (1 1/2-12 lbf ft.).

Item 1 is the torsion rod, made from a length of suitable steel. A material's

suitability can be determined with a simple test. One end is clamped horizontally in the jaws of a vice, a 4 lb weight is suspended by a cord at a distance of 150mm from the vice jaws, a deflection of approximately 1.6mm is required. To determine if the elasticity of the material is suitable, manually deflect the rod to achieve 10mm movement at 150mm and ensure that it returns to the exact original position. A dial test indicator is useful here. Many pieces of 1/4in. steel in my scrap book passed this test, some of the items being a shaft carrying rollers from a discarded photocopying machine, door locking rods from metal cabinet doors, a piece of solid

car radio aerial and a piece of 8mm diameter tubing from the small end of a golf club.

Item 2 is the drive block to accept the extension piece (13) or adapter (14). 3/8in. square was chosen as a compromise between possible sizes of 1/2in. or 5/8in. square drives. The torsion rod is cemented in this block with Loctite.

Item 3 is the scale block and is cemented to the other end of the torsion rod to accept the sliding cursor (10) and a small hand, (4). The M3 tapped hole for the cursor lock screw should be spotted through at a later stage from the 3mm milled slot in the cursor.

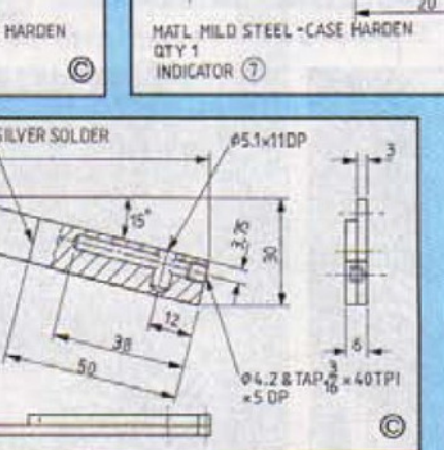
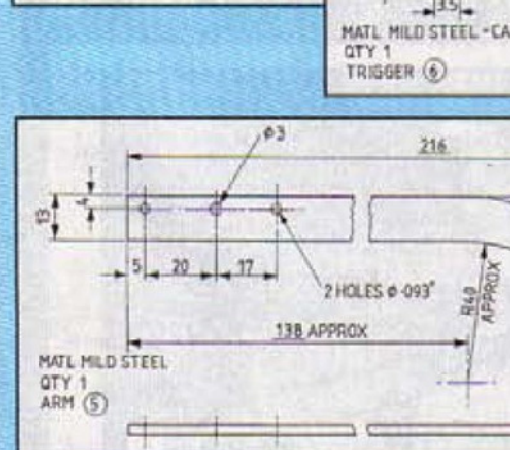
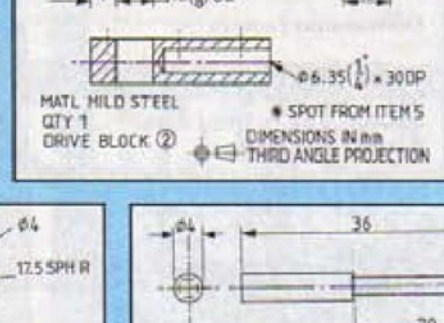
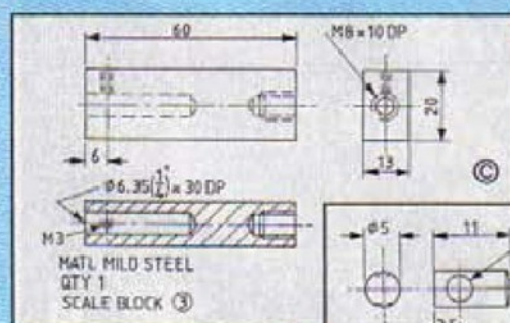
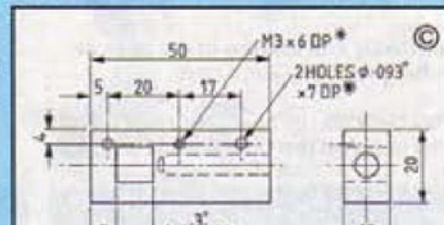
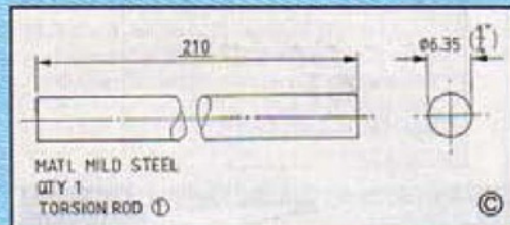
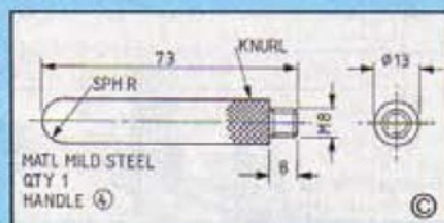
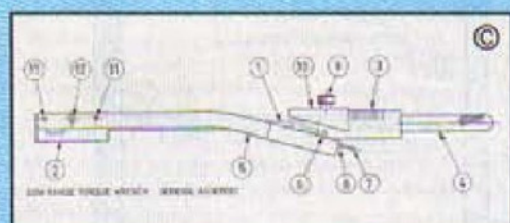
Item 5 is the arm for carrying the trigger and indicator. It is a 220mm length of 13 x 3mm MS bar. It was easily bent with a spanner while heating a narrow band 145mm from the end to a bright red heat with an oxy-propane torch. A 50mm thickening piece is silver-soldered to the short section. A punch mark in each corner will provide adequate capillary space for the silver solder. The bar is secured to the drive block (2), with an M3 screw (12). The dowel pins (11) are necessary to prevent any radial movement which would destroy the accuracy of the wrench. Discarded automobile tail shaft universals are a good source of 3/32 x 3/16in. hardened pins.

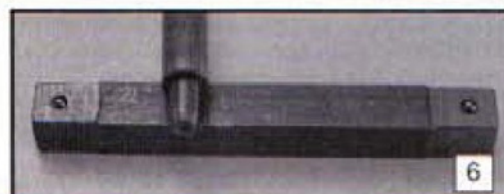
Item 6, the trigger, is depressed by the cursor to release the indicator (7). Exercise caution in centring the cross hole as little material is left. Case harden.

Item 7, the indicator, is free to slide in the 4.2mm hole in the arm, its travel being restricted by the retaining nut (8).

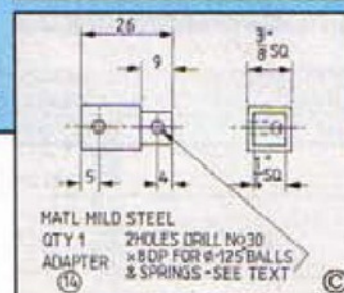
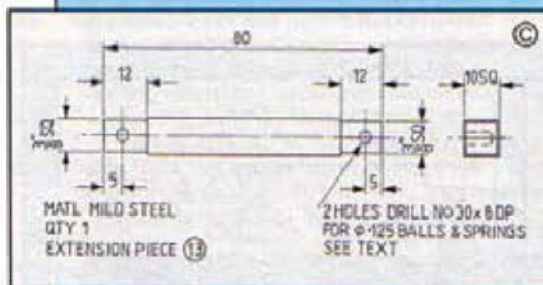
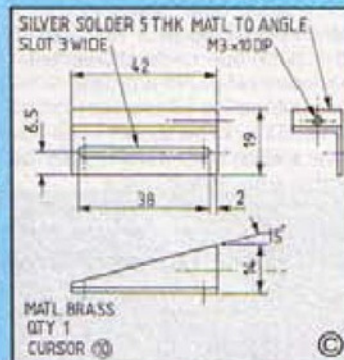
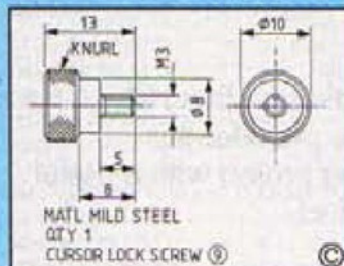
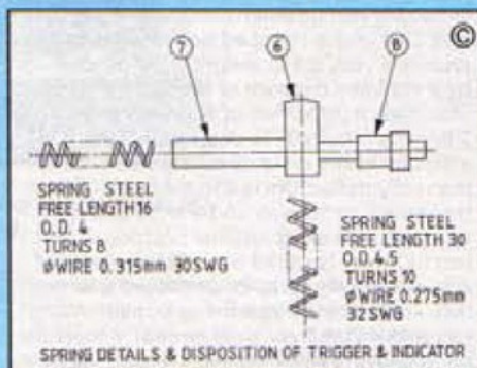
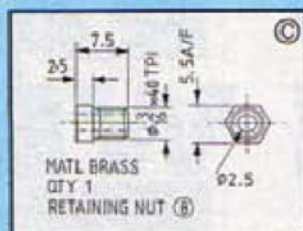
Item 10 is the cursor and is fabricated from a flat brass strip silver soldered to a piece of angle, use of four centre pops will again assist the silver solder to flow evenly. The cursor can be fastened to the scale block while a line is scribed on it from the arm to give the correct machining angle. The M3 tapped hole in the end of the cursor is to accept a countersunk head screw and locknut to act as a scale pointer and to provide a convenient method for future calibration.

Two suggested accessories are shown, a 3/8in. square drive extension piece (13), and a 3/8in. to 1/2in. square drive adapter (14). It is worthwhile to use the punch shown to make the steel balls captive as it will centre itself over the ball while the impression is made. It need not be hardened.





1: The finished wrench.
2: An exploded view.
6: Setting punch for steel balls with



Calibration

Mark the surface of the scale block with a dye, such as layout blue, and hold the wrench horizontal with an extension piece held in the vice jaws. Using a piece of cord, suspend the calibrating weights 225mm (8 7/8 in.) from the centre of the extension piece. Any value of pound weights suspended at this point will be numerically equal to Newton metres. Exercise care in allowing the cord to take the weight as the slightest amount of downward inertia will cause the trigger to operate prematurely. Scribe the dial mill to engrave the scale lines. Finally stamp appropriate.

In using the conversion tables shown the figures may be added or multiplied, e.g. the horizontal row for 6 may be added to the row for 0.5 to give a result for 6.5.

NM		lbf ft
0.6779	0.5	0.3688
1.3558	1	0.7376
2.7116	2	1.4752
4.0675	3	2.2128
5.4233	4	2.9504
6.7791	5	3.6880
8.1349	6	4.4256
9.4907	7	5.1632
10.8465	8	5.9008
12.2024	9	6.6384
13.5582	10	7.3760

Conversion factors

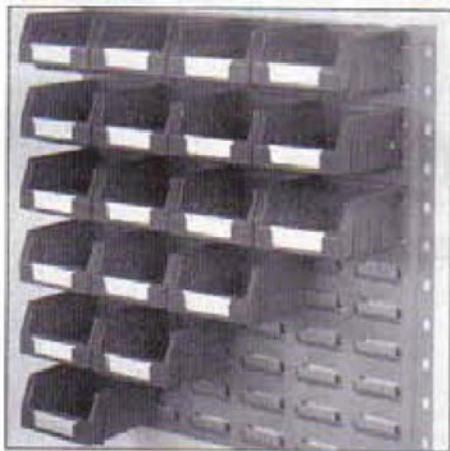
$\text{lbf in} \times 0.083 = \text{lbf ft}$
 $\text{lbf ft} \times 12 = \text{lbf in}$
 $\text{lbf in, divided by } 8.851 = \text{NM}$
 $\text{lbf ft} \times 1.3558 = \text{NM}$

TORQUE COMPARISON TABLES



TRADE COUNTER

Dexion storage systems for the DIY/homecare market



After 47 years selling to commerce and industry, Dexion Ltd - the originators of adjustable steel storage systems - has introduced its first ever product offerings for householders and people working from home. In response to the steady increase in consumer demand for professional quality DIY/homecare products, they have started direct marketing of two Dexion products. A Dexion storage bin system and Dexion's original slotted angle shelving are now available by mail order or telephone.

They are also available through Nurdin & Peacock, Cargo Warehouses and the 47 branches of Trade & Business Centre.

Storage Bin System £17.99 (inclusive of VAT, packing and doorstep delivery) Comprising 24 mid-blue containers in durable polypropylene these can be hung in a variety of configurations on the grey stove-enamelled wall panel supplied.

Slotted Angle Steel Shelving System £19.99 (inclusive of VAT, packing and doorstep delivery)

This steel shelving module comprises three

grey stove-enamelled shelves with upright sections enamelled mid-blue. The uprights are slotted enabling shelving heights to be adjusted and fastened with zinc plated bolts supplied. The shelving module is 915mm high x 915mm wide with a shelf depth of 305mm (3 x 3 x 1ft.). Modules may be stacked to achieve 6 high, 6-shelf units. Each shelf has a load bearing capacity of 400 lbs

For further details, specification leaflet or ordering by credit card, telephone the Dexion Customer Service Department on (0442)342277.

Better than a third hand

The new Panavise JR, is a vice that is more like a tool. Move your work through three planes without removing it from the vice. The head is designed to rotate and swivel 360deg., and is able to pivot 210degrees. One turn of the control knob, and you are able to securely position your work exactly where you want it!



The parallel closing jaws have an opening from 0mm to 730 mm, and are made of strong fibre reinforced thermal plastic for careful but firm holding of your work.

The Panavise JR weighs in at only 587g, yet the body is made of cast zinc which provides a firm base that can also be bolted down.

The versatility of the Panavise JR. makes it perfect for dozens of uses such as soldering, drilling, painting, gluing, assembling, fly-tying, repair, even industrial use; ideal for professionals, weekend professionals and do-it-yourselfers alike.

The Panavise JR has a retail price of £23.44 (including VAT) and will be available from hardware stores, hobby and model shops, or with £4.95 carriage from Longs Ltd, Hanworth Lane Trading Estate, Chertsey, Surrey. KT16 9LZ. Tel 0932 561241 Fax 0932 567391

New home user drill press introduced

A new budget priced, yet precision engineered, bench standing drill press, designed for compact home workshops is now available at all 39 nationwide branches of Machine Mart.

The unit designated CDPSDC, is powered by a 1/2HP 240v fan cooled industrial motor and offers 5 drilling speeds in the range 580-2600 rpm.

A 1/2in. capacity chuck is standard and each unit is fitted with a clear view chuck safety guard. Columns, tables and bearings are precision engineered components and the 165mm x 165mm drill table is fully adjustable for height with provision for 0-45deg. left or right tilting.

The CDPSDC weighs 20kgs, stands 580mm high and is priced at £63.75 excluding VAT.

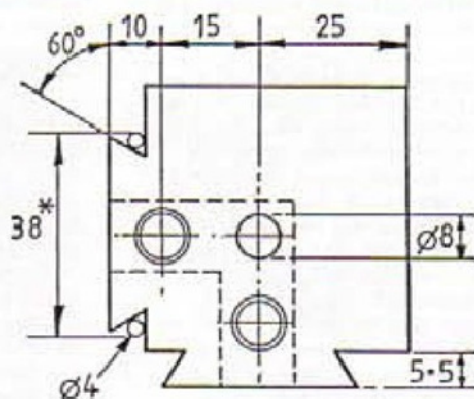
For a copy of the new Machine Mart full colour catalogue detailing the company's entire product line, readers should telephone 0602 411200.



A QUICK CHANGE TOOLHOLDER

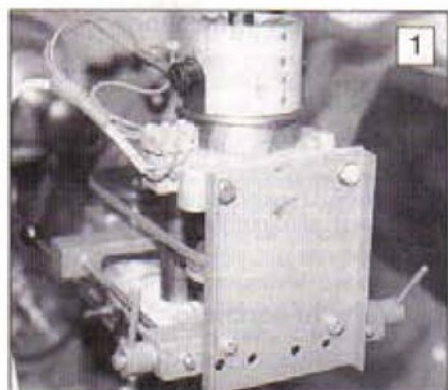
In issue 26 there was an error in the drawings in the above article, we are pleased to publish this correction and apologise for any inconvenience caused

An error occurred in the drawings for the Quick Change Toolholder published in issue 26. This was for the Tool Post on page 17, where the dimension quoted as 28 should have read 38. Please note that this is a reference dimension and the parts should be made to fit each other. Part of the drawing is republished here, being the easiest way to convey the requirements without confusion. Please mark up the drawings in issue 26 with the correction.



*TO BE SLIDING FIT
ON TOOLHOLDER

Model Engineers' Workshop



Limitations

Size, and the limited power to drive it by only a $\frac{1}{2}$ in. diameter belt is the obvious limitation. The other is difficulty of repeatability as there is no keyway between the head and column. Considering the main uses to which the unit has been put, this has proved to be of little consequence. The latter, when used on its own stand-alone base, has now been rectified by the use of a guide bar fixed to column top and rear of the base. The same guide could be used on the cross slide if a small clamp was fixed to the column base, so far I have not had time to make it. (The

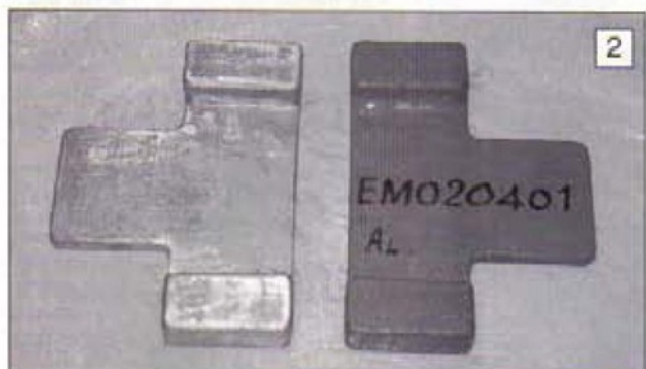
guide can be seen in **photo 16** of the stand alone drilling machine. I have chosen not to include this feature. However, if Derek chooses to incorporate it in the lathe mounting also, it would be worthy of being published as a separate article in a later issue, - Ed.)

Similar small mill/drill head units

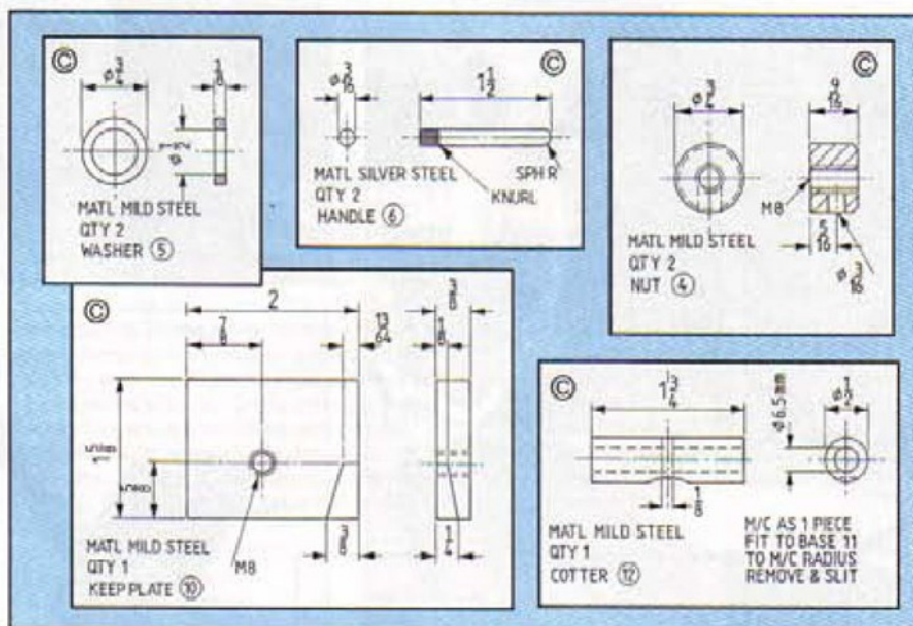
The Emco 3 unit was perhaps the first such unit to be marketed, others have since followed, recognising a good idea. It may be possible to use these alternative units, gaining benefits such as a 1MT internal taper, and collet chucks etc. which are available with some, I consider it would be worth following this line of thought.

Bonus for us older folks

The big bonus is that the column can be fixed to cross slide by screwing it onto the tee slot bolt, or to the lathe bedway by a small block and tee bolt, all of which weigh only a few pounds. Then the head and motor unit can easily be lifted and swivelled around, as this unit weighs in at a light 10 lbs.



- 1: Rear view of the motor mounting arrangement. See safety postscript.
- 2: Casting and pattern for the motor mount assembly.
- 3: Machining the casting.
- 4: Showing how the Emco head is fixed to the motor mount casting.
- 5: Drilling the motor mount bracket.





Important dimensions

Centre of spindle to face of column : 64 mm
 Column diameter: 28 mm
 Quill stroke: 25 mm
 Drill chuck capacity: 0-8 mm
 Spindle threaded, external M 14 x 1 mm
 Length of column: 325 mm

Parts to purchase

Assuming it will be used mainly for milling and drilling with occasional light milling then the parts below will be required. Emco 3 mill/drill head with column and tee bolt and 2 fixing screws. Pt. No. 151-100
 Drill chuck + key Pt. No. 152-500
 Fine feed attachment + screws Pt. No. 151-110
 Slitting saw arbor + bar Pt. No. 151-070

The last two items are not essential but it is recommended that the fine feed is purchased if milling is to be undertaken.

Motor mount casting (From M E Designs) Pt. No. EM 020401

240 V. AC. ex-spin drier commutator motor and mount bracket.

Drill speed controller. This item I made to a design published in *Electronics Today International*, (a Nexus publication, for copies of this article see end of article). It is a simple circuit having only 7 components.

Miscellaneous pieces of steel, screws, washers etc. 30in. of 3/8in. diameter Poly belting. (Before ordering please check that all part numbers are still current - Ed.)



Boring head

A small boring head can be made for this unit, using the taper turning top slide Pt. No. 150-190. Construction of this is fully described in *Model Engineer* Vol. 146 No. 3644.

Manufacture of motor mount assembly

Start with the motor bracket (8) which is a piece of 16swg (or 14swg) steel sheet, or it could be alloy, whichever is available, bend as shown for rigidity. As drawn it suits a Crompton motor, if you have different motor then an alternative solution may have to be found. However, it should be easy, as most spin drier motors are quite similar in size. Before drilling any fixing holes it is suggested that the rest of the assembly is finished. **Photo 1** shows the motor



6: The parts for the belt tensioning arrangement.

7: The complete motor mount assembly.

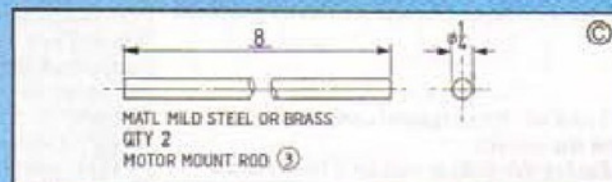
8: The complete head assembly, with other small items.

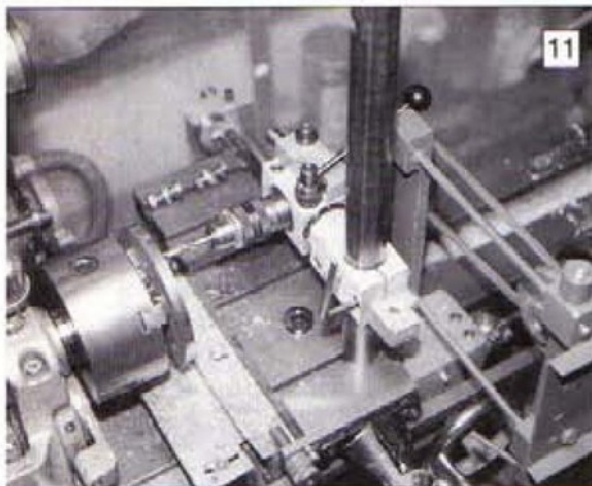
9: The Emco column with the home made block for mounting the column onto the series 7 bed.

Get the Emco 3 mill/drill head and fit the casting over the fixing plate, that is under

Set up the clamp assemblies as depicted in sectioned view, fixing them in place with just half of one spot of Super Glue. At this point the nuts are without handles for ease of handling. Leave a few minutes to set, then clamp down firmly protecting the casting with card, ensure your drill will not damage the table on break through. Then, using the pre-drilled holes, drill right through $\frac{3}{16}$ in. diameter and ream $\frac{1}{16}$ in. diameter. Chamfer both sides of the hole deeply. Fit a $\frac{3}{16}$ in. diameter bar in the nut and tighten further to break the glue bond. Extract the assembly and clean off any glue residue, then slip the reamer back through

Measure the bedways of your lathe, this could vary if it has been reground. Mark off and machine to suit so the block will be a good fit between the ways. It remains only to make the keep plate (10) from a piece of BMS. The block and keep plate were chemi-black finished to suit the column and oiled. The unit can be seen in use in **photos 10, 11 and 12.** (*Photo 12 appears on the front cover - Ed*). Photos 10 and 11 show the unit mounted on the cross slide; 12 shows it on the bed. The bed mounting block can be seen left in position in photo 10.





11

Used as a stand alone high speed drill

Until I made this unit I had no high speed drill sensitive enough for drills below No 60. A pal had constructed a 3/8in. capacity drilling machine with a set of castings from Reeves. It was a fine machine, and still is after about twenty years of use. The base gave me the idea, use the casting for this, and the Emco 3 mill/drill head, to make a very adaptable small drilling machine. It would provide an infinitely variable speed range up to 6000 rpm, and this should cover most, if not all, of my needs. All I needed was the base. However after some thought, I bought the drill table arm casting also, reasoning that this could be used as a tapping guide with the head unit removed.



13

Uses

The main use would be the drilling of small components, but by removal of the head and replacing it with the arm it could be used to guide taps for accurate tapping. A further possibility, though not yet undertaken, will be to use it for accurate number and letter stamping in a manner similar to the George Thomas designed Tapping and Staking tool.

Limitations

The main limitation is the limited throat gap.

Future possibilities

In the future a small compound table will be completed to enable it to be used as a small milling machine, similar to the Emco U3 machine. In fact work on this has now been started, but this is more a case of rounding off the project than of a necessity.

Parts to purchase

Drill base casting in cast iron. A. J. Reeves & Co. Ltd. Drill table arm in cast iron. A. J. Reeves & Co. Ltd. When obtaining a quotation from Reeves for these two parts, quote reference P030294D.

Manufacture

Check the base casting (11) to ensure that there are no cracks, in particular in the boss supporting ribs; a blow hole in the flat base or boss is of little consequence. Then run a file over the top face to remove any small lumps as it has to be sat down upon this surface for the first operation. First make the column clamp bolt assembly; this must be done now or you are in danger of putting the cart before the horse. If you can find a steel bolt of suitable size and length, and nut to fit, you will not have to make one. The cotter (12) starts life as one long collar, but is later cut into two

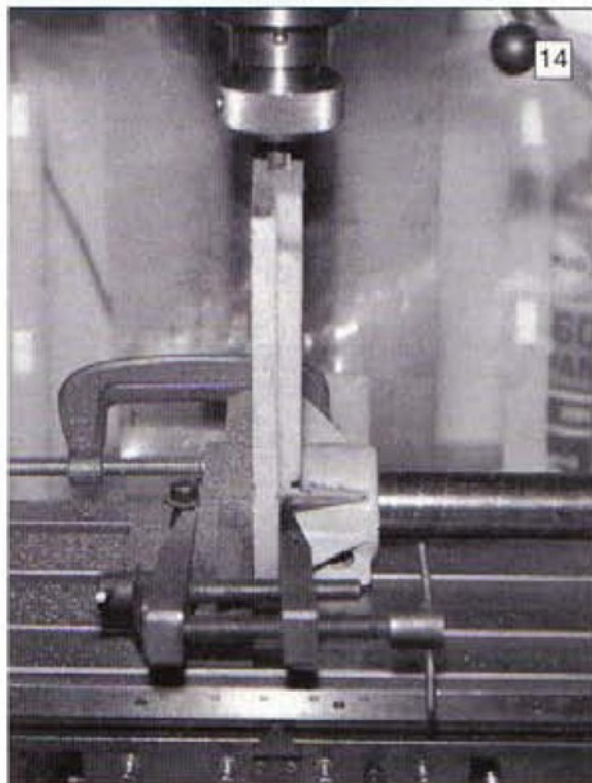
as on the drawing, so cut to length, drill it through, lightly chamfer both bore and outside diameter. Assemble with screw, nut and washers, then put aside for the present. Coat the side of the boss on the base casting with a suitable marking out fluid, mark out the cross lock hole, plug the cored bore and coat the top of the plug. The plug should not enter the cored hole sufficient to reach the lock hole, or else it will not be possible to remove it at the stage required. Remember the

1 1/4in. dimension is from the machined surface, not yet machined, so allowance must be made for this. Work can now be started on the casting. Support the top face, which you have filed flat, on two reasonably thick parallels. If necessary, pack up with thin shims, to avoid any possibility of distortion. Great accuracy is not required for the under side, just a good uniform machined and flat surface overall.

Remember the boss is downwards at this point, it must be clear of the table. You can machine the underside on the mill using an endmill or flycutter. It appeared too large for the faceplate and was not therefore tried, it just might be possible on a large faceplate. It was obvious that it was far too large for any vice I had, so an extended loose jaw type was dreamed up. (see *Large Capacity Two Part Vice* in issue 20, -Ed). I have fitted my own design of slow speed attachment to the Hobbymat mill, and with a flycutter in my Westbury boring head, machined the under side in two sweeps, running the mill at 78 rpm, taking my time to get a fine finish. Apologies, I was so relieved to get this under side done without a clanger I forgot to take a photo. I then reversed the casting so that it sat upon two parallels with clamps, as seen in photo 13, and machined the table top in a similar way, again using the flycutter. This produced a flat surface. However, should you not have milling facilities, it is possible to get by with just a good file, straight edge, patience and bags of elbow grease. Constantly check progress by rubbing with marking compound onto an old mirror glass, or surface table, the way that apprentices were once taught. Take as little off the table top as is necessary to get a surface machined all over, more material equals more strength to resist distortion.

Remove and reclamp to an angle bracket, the flat at the rear of the boss to be vertical, and then drill the cross lock hole 1/2in. diameter. Now try the lock bolt assembly in the hole and after cleaning out the hole fit this with just one spot of Super Glue, fit it as shown on the drawing. After about 1/4 hour check that it is firmly fixed. At this setting, prior to removing from the angle bracket, the four base fixing holes can be marked off using a surface gauge on the machine table.

Return to mill as in photo 13, put a centre finder in the mill chuck and pick up the centre of the boss, then remove the plug from the centre. Change the chuck for a boring head and carefully bore the cored hole out to 28mm diameter, a close fit on the column. Partway through the sound will change, this is when you are starting to cut through the cotter, as it is mild steel, so take it steady at this point. Take the last cut through several times at the same setting to ensure the hole is parallel. Tap out the cotter assembly. Change the boring head for a drill chuck, slacken the clamps and



14

10, 11 and 12: Three typical uses for the unit. (12 on the cover.)

13: Boring the drilling machine base for the column.

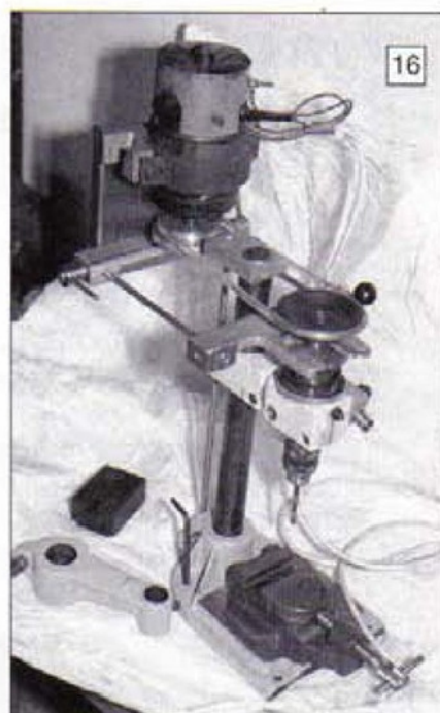
14: Machining the front end of the base.

The final item is the cotter, this can now be cut into two parts. De burr the cut-aways deeply to give a lead into the column.

It is intended to give only a brief description, the Emco 3 column, drilling machine base, an arm casting and relevant guide bushes and chucks to hold taps or stamps are used. The arm being an iron casting for the drill table and supplied by Reeves.

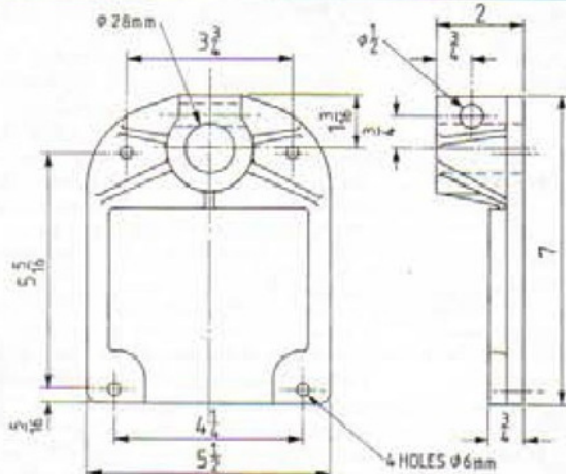
Safety postscript

Some photographs in this article display serious safety weaknesses. I feel more is achieved by publishing them, with the following important observations, rather than omitting them from the article -Ed. While the terminal block seen in **photo 1**, and others, is what is called "finger proof", it is not sufficiently safe to use unenclosed. A poorly fitted cable, (loose strands etc.) or a small piece of metal swarf, could easily defeat the finger proof protection making it potentially lethal. As the built in flying leads of the motor will require extending, the terminal block must be fitted into a totally enclosed, preferably plastic enclosure. Also lead to such items as the terminals in the photograph must be fitted with foolproof strain relief, even when fitted into an enclosure. The fan on the motor is also too accessible, and must be fitted with a finger proof guard.



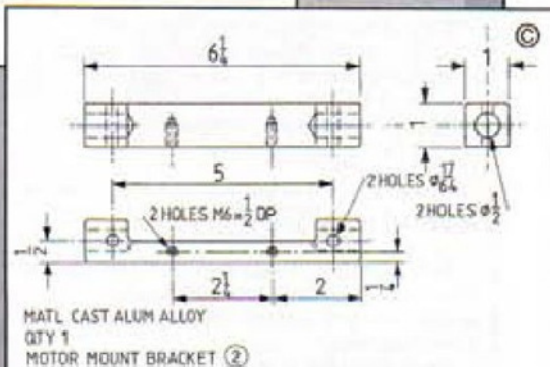
15: Boring the drilling machine table arm for use as a tapping fixture.
16: The complete sensitive drilling machine.

Emco Maier Ltd. 10 Woodshotts Meadow, Croxley Business Park, Watford,
Herts, WD1 8YZ. Tel. 0923 250051. Fax. 0923 243908.
M.E. Designs, 53A London Road, Tetbury, Glos, GL8 8HP.
A J Reeves and Co. (B'ham) Ltd. Holly Lane, Marston Green, Birmingham, B37
7AW. Tel 021 779 6831. Fax. 021 779 5205.



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Copies of articles previously published and mentioned above can be obtained, £3.50 for UK readers, plus £1 p&p, overseas readers plus 30%. Requests should be sent to Photostat Service, Nexus Special Interests Ltd, Boundary Way, Hemel Hempstead, Herts HP2 7ST.



SCRIBE A LINE

Beginner seeks help.

David Commerford of Co Neath Ireland would like some information and guidance. I do hope some reader can offer some.

I read with interest your magazine No 22 about South bend lathes (I am, I should explain new to this).

I recently bought a South Bend lathe from an elderly man who reluctantly sold it to me. It is I should say nearly new. With the lathe were its original manual and catalogues and a book "How to run a lathe".

Inside the catalogue is a piece of paper dated Sept 1941, explaining, due to the National Defence Programme, machine tools are being allotted to those industries that need them most, etc.

I would like to know more about these lathes and their history. I would like to speak to Irish lathe owners, not just South Bend owners. Is there a society or guild I can join in Ireland?

Being a woodturner and earning a living at this I was on the Committee of the Irish Woodturners Guild for four years and helped organise many workshops and seminars.

I also have a Drummond metal turning treadle lathe 10in. between centres and in perfect working order. This machine, I feel, was an excellent machine and still is in my opinion. I would like to know more about this machine and I would like to make contact with others who would be willing to help one understand the machines I have better than I do. I would welcome correspondence from anywhere.

And from D Stott of Nimmitable, Australia.

I have just received the Sept/Oct issue of MEW. On page 35 you request information regarding the screw cutting gearbox illustrated. This gearbox was designed by L H Sparey and a constructional article was presented in Model Engineer. I am not certain of the exact date but it would have been probably between 1956 and 1960.

I emigrated to Australia in November 1964 and brought all my tools including my ML7 lathe with me. I was unable to bring all copies of M.E. but cut out any articles of interest including that for this gearbox. Unfortunately the dates are not on the pages, only the page numbers.

A small (engineering) world?

B Jackson of Sunrise Park, Republic of South Africa, spots some remarkable similarities with a recent MEW and a 1911 magazine.

Issue 24 of MEW arrived a short while

ago and as always provided excellent reading. Anyway, a few days ago a friend lent me a bound volume of The Model Engineer and Electrician. This contained issues from July to December 1911.

To my astonishment the Nov 16 issue of M.E. & E. describes a 'surface gauge with fine adjustment' by a John Heyes welcome datacompand which tool bears a remarkable likeness to the one on page 31 issue 24 of MEW.

Even more remarkable is that in the Nov 23 issue there is a construction article for a 'Micrometer Stop' which is not much different from the 'Graduated Saddle Stop' on page 26 of issue 24 MEW.

Alan Jeeves comments on his discovery.

Thanks to Mr B Jackson of S Africa for sending copies of the November 1911 Model Engineer & Electrician. Of particular interest to me is the article on the 'Surface Gauge with Fine Adjustment' as my own short article for a similar device has been published recently in MEW.

Years ago when I was an apprentice I was given the height gauge to make as an exercise. This tool, made all those years ago, is pictured on page 36 of issue 24 and as can be seen it has a brass base but no fine adjustment. I assumed that the design of the gauge was attributed to the fine craftsman who enticed me to make it but he must have been influenced by the effort which Mr Jackson dutifully draws to our attention. My master would have been born around 1910 so it is quite possible that the design was handed down to him by his master (or perhaps his father). What Mr Jackson has provided us with is a perfect example of how ideas and designs are handed down through the generations.

I had not read the 1911 magazine prior to my own article being published but had I have done so it would not have deterred me from submitting mine for print as I consider it a fine, useful exercise for the amateur engineer to tackle. I know of some that have been made from my article which, had it not have appeared in MEW, would have been missed altogether (I understand that the 1911 M.E. & E. has now been withdrawn from newsagents shelves).

It is a fact, however, that when researching a subject for consideration as a magazine article reference is often made to other sources (including other articles) in order to provide as much useful information to the modern reader as possible. One example of this is where the subject is a moribund process such as my recent article on 'Laps & Lapping'. If reference can be made to Model Engineer - No.2579 (Oct 26 1950), page 649 holds an article by M. Hall on the

same subject. A flat lap is illustrated in a wooden box. I used this idea myself when I decided to make my laps (long before my article) and I have, hopefully, passed the idea on.

Well done Mr Jackson on spotting these articles which are so alike, but yet 83 years apart.

Gearbox origin solved.

A number of letters have been received on this subject all pointing to the same source. Here are two.

From D Machin of Rotherham.

Re the article on Guy Keen's workshop. I am almost certain that the gearbox on the ML7 is one made to the (M.E.) Sparey design, the drawings for which, I believe are still available, but castings unfortunately are not (I have a set of these drawings, bought 20 years ago).

The photo shows what appear to be a well made version, though the mounting method is perhaps little weak (from a design point of view). It would be interesting to know who made it. I was particularly interested in this, because it was on this design that R. Altham and later I, based a revised design for a similar gearbox. The Altham design was for a fabricated version for the ML7/Super 7. My contribution was merely a version using castings. The "innards" are much the same for all three. I wrote an article for M.E. on the construction of the gearbox.

Readers may like to know that drawings, instructions and castings for the Altham/castings version are still available from NS & A Hemingway, 30 Links View, Half Acre, Rochdale, Lancs OL11 4DD. Tel: 0706 45404. (Hemingway also provide a kit for an ML10 gearbox).

From David Galer of Bexley.

In the article concerning Guy Keen's workshop in MEW No. 25 information was sought about the origin of the gearbox fitted to his Myford.

This is illustrated in the book A Man and his Lathe by L H Sparey. This was published in 1951 by Tool News. The latter was part of T Garner & Sons Ltd, Hand and Machine Division, Redbrook Works, Gawber, Barnsley, Yorks. There is an advertisement by Garner's which states "Please ask for details of the Sparey Screwcutting Gearbox for the ML7 Lathe".

I believe that the gearbox was designed by L H Sparey and castings were available from Garner's. However I do not have confirmation of this.

